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WE GUARANTEE, that of this issue more than 9,000 copies were printed; that of those more than 9,000 copies 7,535 were mailed to regular paid subscribers to the Railway Age Gazette, weekly edition, and Railway Age Gazette, Mechanical Edition; 224 were provided for counter and news companies' sales; 241 were mailed to advertisers and correspondents; and 1,000 were provided for distribution at Atlantic City.

The Future of the Mechanical Stoker

A part of the report of the committee on mechanical stokers which should be of decided interest is the paragraph referring to the difficulties attending the design of a machine to suit present locomotive construction, because of the absence of choice as to the arrangement, the limitations of space and the conditions under which the machine must operate. It is believed by the committee that in time, greater latitude will be given the designer and consequently more will be accomplished. A brief survey of the number of mechanical stokers now in use on locomotives and the number of different machines that are being developed in this field should be sufficient to convince the most skeptical that mechanical stoking has come to stay. Most of the stokers now in use are designed to be applied to the locomotive; whatever designing there is in connection with the application is done along the lines of making the machine fit the present standard of locomotive construction and of course a prime consideration has been to provide a machine that will not interfere with hand firing when that becomes necessary. No one would ever think of fitting the old type of boiler feed pump to a locomotive for emergency purposes in case of trouble with the injectors, and is it not reasonable to expect that in the near future the mechanical stoker will occupy as firm a position as that now occupied by the injector in locomotive operation? Under such circumstances it would seem that it would be a step in the right direction to design and construct a locomotive for test purposes along lines which would be the most suitable for the application of a mechanical stoker. Aside from changes in the back frames and probably some in the construction of the front of the tender, the greatest changes would likely be in the firebox and grate construction, but it does not seem that any of these changes should necessarily be revolutionary. If the work were carefully carried out the results obtained should prove of decided value in indicating the line along which the development of the stoker of the future should follow.

Enlarging Standard Practices

President MacBain's point as to the diversity in practices on different railways is well taken. Even considering the variation in conditions in different parts of the country, there is no reason why there should not be more unification of methods than now prevails, with the probability of corresponding economy. Much has been done by the two major mechanical associations in the introduction of standards, but there are still many things to which they can turn their attention to advantage. There will have to be much done in the way of bringing together diverse opinions, but this has been done before and can be done again; and, indeed, if the letter of President Ripley, of the Atchison, Topeka & Santa Fe, which was read at the Master Car Builders' convention, is to be construed as an active start toward the attainment of the long-talked-of standard box car, there will have to be a greater leveling of contrary opinion and practice than there has yet been.

Improving the Drawing Office

The statement was recently made by a shop officer that in a long experience working in conjunction with the mechanical engineer's office of his road, he did not believe the shop expenses had been increased by more than ten dollars because of drawing office errors. This is certainly a splendid tribute and indicates a relationship between these two branches of the mechanical department, in this case, that is to be greatly desired and which is, unfortunately, too rare on railroads in general; but the fact that the mechanical engineering work on this road is provided for on a broad basis, permitting the development of a well-organized and efficient staff, has probably been a large factor in bringing about this condition. Mechanical men well know the time that is lost on many roads by machinists and draftsmen running back and forth between the shop and the drawing office because of mistakes or a lack of information on drawings, to say nothing of that lost by the holding up of work from similar causes. Much of this can be avoided, even under the generally prevailing conditions, and while the high degree of perfection indicated in the statement referred to above cannot be attained in every case, it forms a good mark at which to aim.

A Better Convention Hall Needed

The work of the two mechanical associations is becoming of such great importance and the reports which are being prepared and presented are so far superior to those of a number of years ago that it is a shame that better opportunities are not afforded for an effective discussion in the way of a more suitable meeting room. It is true that the present convention hall was enlarged a year or two ago, but it is inadequate in the point of size to properly handle all of the members and visitors who would like to hear the discussions. Moreover, its acoustic properties are far from perfect and it is entirely unsuited for transacting the business which must be handled. This condition has existed for some years, and from present indications no effort is under way to remedy it. If we are to continue to come to Atlantic City each year something should be done at once to secure better meeting hall facilities. If we are to go elsewhere then some provision

should surely be made to insure attention being given to this important feature.

The halls in which the various mechanical department organizations hold their meetings throughout the country are in almost every case open to the criticisms which apply to the hall on the Pier. One cannot help but contrast the meetings of our great mechanical department associations with those of the American Railway Engineering Association which meets in the Congress Hotel at Chicago. There the room is large, the ventilation is good and the acoustic properties are splendid. There are no disturbing noises. It is so arranged and is of such a shape that all of the members are within a reasonable distance of the platform. Good results cannot be obtained where a meeting room is long and narrow, as is the case with Convention Hall on the Million Dollar Pier. The shape of the room at the Congress Hotel makes it possible to place a large long table on the platform, and it is the custom to have every member of a committee sit at this table facing the meeting when a committee report is presented. This has several advantages. The members of the committee are collected together and if necessary can confer before replying to any questions or criticisms, and they are within reach of the chairman of the committee so he can call upon the one who is best fitted to answer any of the questions. The effect of this arrangement is to dignify the entire proceedings and without doubt it has some effect in inspiring the committee members each to do his full share of the work in the preparation and compilation of the report. Without doubt those members of our associations who have visited the engineering convention at Chicago would like to use the same arrangement here if conditions would permit.

Another feature which should be attended to in providing for a more suitable hall is a means of getting into and out of it with the least possible disturbance. The single entrance at the rear of the long hall and the crowded condition of the chairs in order to take care of the large number of members who wish to attend the meetings are factors which do anything but contribute to the effectiveness of the meetings. There must be many meetings held in Atlantic City similar to ours and it seems strange that better facilities are not available.

THE MECHANICAL STOKER

THE expected happened, and the efficiency curve of the convention had a crook put in it by the discussion on mechanical stokers yesterday morning. It was a sane statement of facts and observations with a most optimistic tendency. The old fear that the machine was extravagant in the use of coal has largely disappeared, and now we have the encouraging thought that, if the stoker does use more coal per engine or train mile, it is either because of the fireman's neglect, or because more work is being done. The stoker is being regarded as an economical machine rather than as a luxury for the sole relief of the fireman's back. And there is every reason why this should be so.

An engine that can do the work attributed yesterday morning to the Hanna stoker, for example, of holding steam pressure against two injectors on a heavy pull, and keeping a smooth, bright fire over the whole run, must be burning coal to good advantage. Smoke elimination must mean improved combustion and better heating values, unless there is an over-admission of air to cut down temperatures and waste heat, but of this there is little danger, under present conditions at least; and no one who has watched the fire conditions in locomotives fired by hand and with a stoker can have any doubt as to the superior efficiency of the latter's work.

The stokers of two or more years ago were undoubtedly wasteful, but a part of their wastefulness must be attributed to the fireman. The fireman must keep his engine hot, and he does not care to run a risk by a curtailment of the coal supply, so he over-feeds and wastes coal. It now remains to so educate him that he will be content to carry a thin, bright fire, and rest assured that it will keep his engine hot.

As for quality of coal, there must be differences in stoker adjustments to meet fuel variations, just as there must be adjustments to meet work variations. But there is every evidence to bear out Mr. Street's statement that a stoker can handle any fuel that can be successfully fired by hand, whether it be slack, a bituminous-anthracite mixture, or straight run-of-mine coal.

Of course, the fireman is very much to the front in importance in this matter, and it is on his personality that much of the stoker's real success depends. It has been repeatedly stated that all the stokers now being used can maintain a uniform steam pressure. This is borne out emphatically by certain reports that are available; in fact, some engineers are firmly convinced that stoker-fired engines can be kept hot with fire conditions that would be impossible with hand firing. Instances can be cited of stokers whose distribution was very bad, whose fire-bed was in heaps at the door and the front corners, with the back corners bare, and yet holding up steam pressure in a way that left nothing to be desired. Far from economical, to be sure; in fact, wasteful in the extreme, but still holding pressure. Whether this bad distribution was due to the fireman's neglect or to faulty stoker construction does not concern us here. It simply shows that the stoker can do some things that the shovel cannot.

Of course, the stoker is not yet a finished product, but when such performances are possible as were cited yesterday morning, it certainly indicates an efficient mechanism. When Mr. Crawford states that out of 100,000 trips on the Pennsylvania Lines West, 60 per cent. of them showed 100 per cent. work on the part of the stoker; or the instance cited by Mr. Fowler of an engine leaving the roundhouse and not having a shovelful of coal put in the fire-box in hours of waiting and running on the road; or where we hear of trip after trip being made without an opening of the fire door, we cannot but conclude the mechanism to be well advanced in its stage of development, even though it may not yet be perfect. Undoubtedly trouble will develop as stokers are numerically increased, but that holds of the air brake, steam heat, and even of the locomotive itself.

One speaker stated that the time was fast approaching when the stoker would be considered a commercial necessity. It looks as though, in some places, that time had arrived. Hot weather, large fireboxes and heavy trains, mean much coal and a hot fire. Here is a limit to human capacity and where the second fireman is put on an engine for five months of the year, the stoker has an excellent opportunity for paying big dividends. Eighty dollars a month for five months would go far toward paying a very respectable interest on the cost of a stoker and its application, and that is precisely the situation that is facing some railroads.

There is one thing on which all speakers were agreed, and that was the sustained steam pressure that can be obtained with the stoker. Surely this one thing alone should be a sufficient recommendation, for the most ardent believer in hand firing could not maintain such a claim.

Reliability or the lack of it is the bugbear that frightens some. Undoubtedly there are stoker failures and quite as undoubtedly they will continue to the end of time, and the man who waits for the perfect and infallible stoker will never put one on his engines.

Viewed from the outside, from what was said yesterday morning, it looks as though discussions on the availability of the stoker were about at an end, and that hereafter we would hear more of what had best be done, rather than of whether it had best be done at all.

PROGRAM FOR THE WEEK

MASTER MECHANICS' CONVENTION

TUESDAY, JUNE 16

Discussion of Reports on:	
Locomotive Headlights	9.30 A. M. to 10.15 A. M.
Design, Construction and Maintenance of Locomotive Boilers	10.15 A. M. to 10.30 A. M.
Standardization of Tinware	10.30 A. M. to 10.45 A. M.
Superheater Locomotives	10.45 A. M. to 11.30 A. M.
Use of Special Alloys and Heat-treated Steel in Locomotive Construction	11.30 A. M. to 12.00 M.
Individual Paper on:	
Review of the Work Done by Other Mechanical Organizations, by Dr. Angus Sinclair	12.00 M. to 1.00 P. M.
Subjects	1.00 P. M. to 1.30 P. M.

TUESDAY, JUNE 16

10.30 A. M.—*Orchestral Band Concert.* Entrance Hall, Million Dollar Pier.

3.30 P. M.—*Orchestral Band Concert.* Entrance Hall, Million Dollar Pier.

9.30 P. M.—*Informal Dance, Special Feature Dancing.* By Mr. Evans and Miss Wynn. Entrance Hall, Million Dollar Pier.

THE BALDWIN TRIP

The trip to the Baldwin Locomotive Works to see the Erie Triplex locomotive has been called off. The officers of the Master Mechanics' Association felt that because of the very limited time at the disposal of the members to visit the exhibits on the Pier it would hardly be fair to the exhibitors, who had gone to heavy expense to bring their devices here, to arrange for a trip which would take a large number of the members away from Atlantic City for a greater part of a day.

R. P. C. Sanderson has announced that if any of the members are interested in seeing the locomotive and will call at the office of the Baldwin Locomotive Works in Philadelphia, arrangements will be made to take them at once to the Eddystone plant, where the engine now stands tuned up ready for service. The trip to Eddystone will be made by automobile, so that the engine may be seen with a minimum loss of time and a minimum of discomfort.

LOST

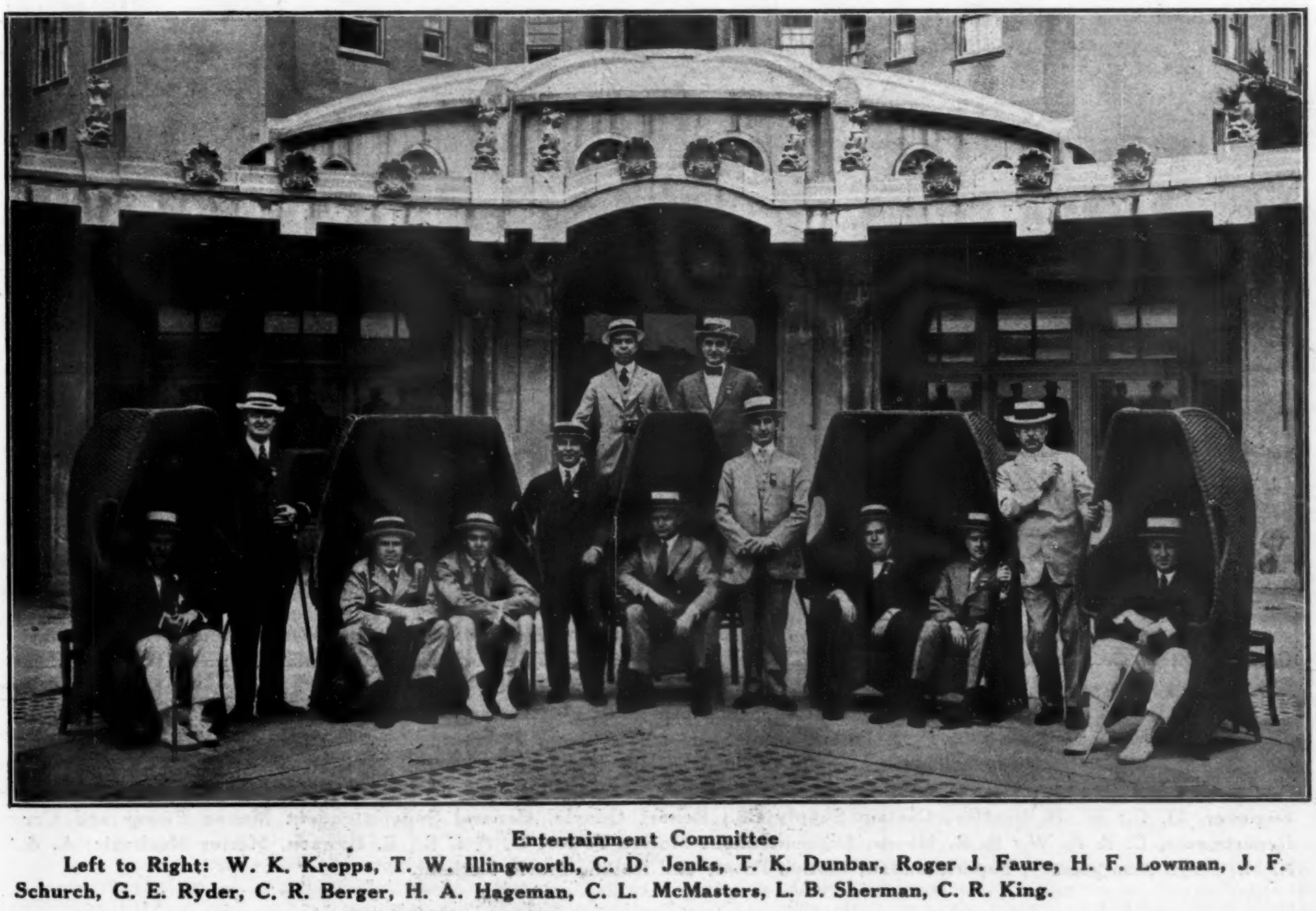
John P. Landreth bemoans the loss of his pocketbook, containing money and memoranda. The finder will please return it to the owner, 576, Marlborough-Blenheim.

An oblong buckle pin with an onyx center and rhinestones around it was lost at the dance last Thursday. Finder please return to F. O. Bunnell, Room 4, Dennis.

M. M. INFORMAL SOCIAL GATHERING

Monday evening an informal social gathering and dance was given at the Marlborough-Blenheim, some three hundred convention people attending. The presentation of the golf cups as the prizes of Sunday's tournament also added to the interest and pleasure of the evening.

The entertainment committee was represented by the following gentlemen, who were in charge of the affair: E. E. Silk, chairman; C. D. Jenks, C. D. Eaton, C. R. King, T. W. Illingworth, George R. Carr, R. J. Faure and C. R. King.



Entertainment Committee

Left to Right: W. K. Krepps, T. W. Illingworth, C. D. Jenks, T. K. Dunbar, Roger J. Faure, H. F. Lowman, J. F. Schurch, G. E. Ryder, C. R. Berger, H. A. Hageman, C. L. McMasters, L. B. Sherman, C. R. King.

NOTES ON THE EFFICIENCY DIAGRAM

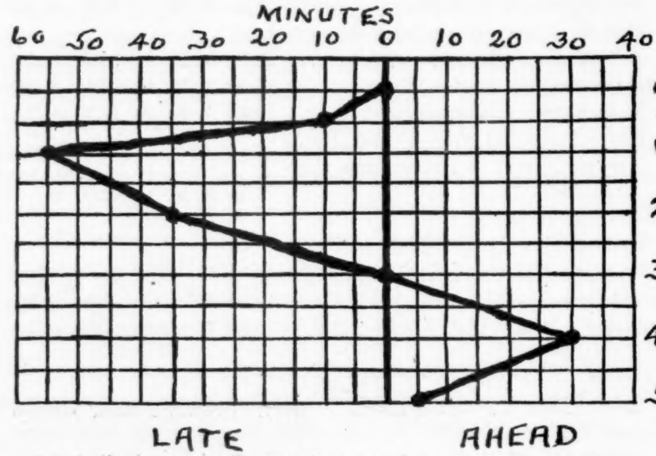
BY A VICE-PRESIDENT WHO KNOWS THE MEN.

The business portion of the session, with MacBain at the throttle and Joe Taylor firing, finished right on the dot, including the distribution of mail from the head end while in motion. When it came to the locomotive stokers, the tonnage having been so increased over hand firing, time was lost, but "she tipped over the hill" a trifle late, but blowing off.

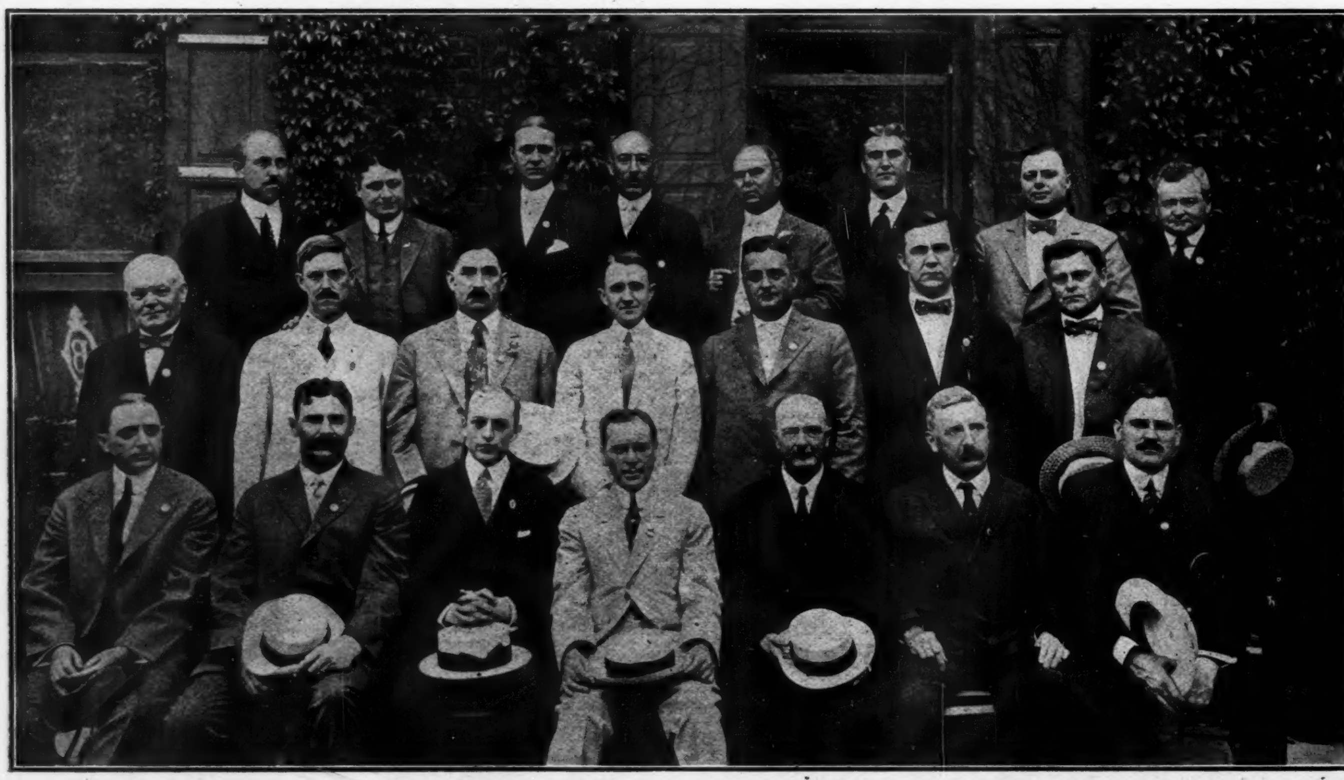
At this stage Engineer MacBain opened the left cab window to give air to Fireman Fowler, who was making his 800-mile stoker trip. (By the way, what Fowler said about the economy of a lazy fireman may be a disclosure of a part of his autobiography.) Street handled his stoker without sweating a hair—that is, his hair. Several members who listened to Crawford on his "underfed" stoker expressed the opinion that his personal appearance belied the belief that he was fed in that way, as vouched for by Cook (T. R.).

The standards committee, with Dunham, of the "old reliable 'North Western,' handling the tissues," made up 20 minutes, followed by the non-stop run of MacBain, due to the perfection of his "Safety Appliances," Gaines' hand on the "wind jammer."

When Foster, of the Lake Shore, coupled up both injectors, the discussion brought the convention to their Kneass by the knowledge that we had 157 varieties on this pier, as against only 57 up the boardwalk. Schedule 1.00 P. M. Actual time, 12.31¾ P. M. (So far ahead of time that the train could not wait for Kuhns, who was not on the platform, hence Dunham gave Mac the "high-ball" and moved the controller into the "motor drive" slot, concluding with a moving picture show (as seen in the paper) at 1.25 P. M., exactly five minutes ahead of time.)



The Mechanical Stoker Surely Balled Things Up



The Chicago & North Western Club

Top Row, Left to Right: J. A. Kinkaid, Parkesburg Iron Co.; J. R. Mitchell, with W. H. Miner; C. B. Friday, Carnegie Steel Co.; W. G. Wallace, American Steel Foundries; E. J. Arlein, W. H. Coe Manufacturing Co.; Edward Ryan, Ryan, Galloway & Co.; J. L. Nicholson, Locomotive Arch Brick Co.; Edward Williams, Pittsburgh Steel Foundry Co.

Middle Row, Left to Right: George Wagstaff, American Arch Co.; George L. Bourne, Locomotive Superheater Co.; J. W. Kelly, National Tube Co.; E. J. Fuller, Hunt-Spiller Mfg. Corp.; T. W. Aishton, The National Malleable Castings Co.; Geo. Spengler, Locomotive Superheater Co.; John P. Neff, American Arch Co.

Bottom Row, Left to Right: W. E. Dunham, Supervisor of Motive Power, C. & N. W.; J. A. McRae, Mechanical Engineer, M. C.; W. H. Bentley, Curtain Supply Co.; Robert Quayle, General Superintendent Motive Power and Car Departments, C. & N. W.; B. R. Moore, Superintendent Motive Power, D. & I. R.; E. Dawson, Master Mechanic, A. & N. M.; Hugh Montgomery, Superintendent Motive Power and Rolling Stock, Rutland.

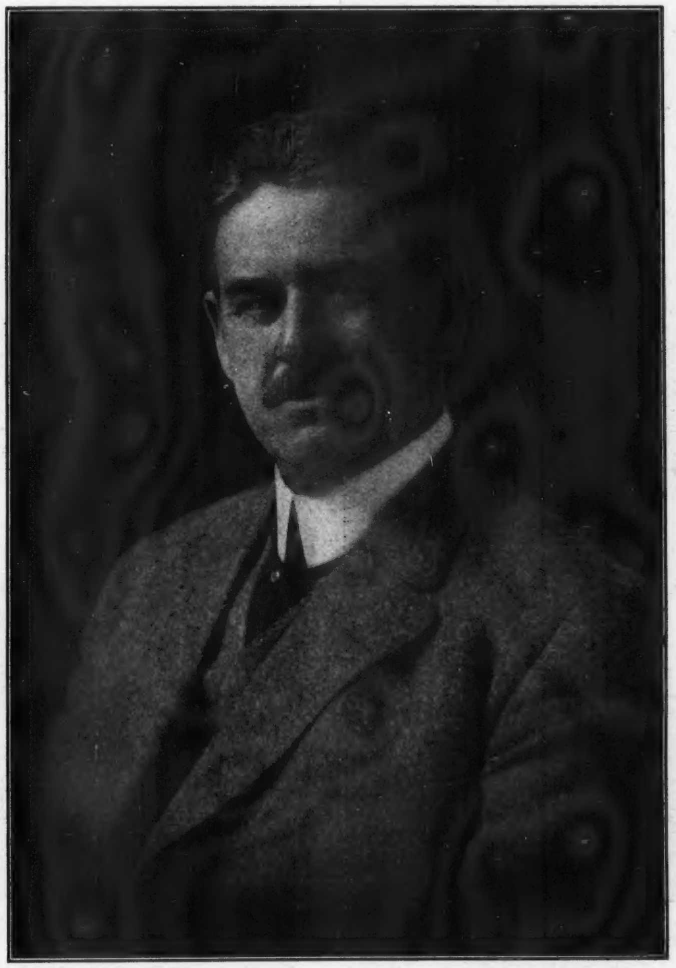
Master Mechanics' Association Proceedings

Includes Address of President MacBain, Report on Mechanical Stokers and Paper on Motors in Railway Shops

The first session of the forty-seventh annual convention of the American Railway Master Mechanics' Association was held at Atlantic City, June 15, 1914. President D. R. MacBain called the meeting to order at 9.45 a. m. The past presidents of the American Railway Master Mechanics' Association and the Master Car Builders' Association, and all officers of both associations were invited to take seats on the platform. The opening prayer was offered by the Rev. W. Spurgeon, pastor of the Olivet Presbyterian Church, Atlantic City.

PRESIDENT MAC BAIN'S ADDRESS

I am pleased to greet you, one and all, and welcome you to this, the forty-seventh annual convention of the American Railway Master Mechanics' Association. It surely is with a feeling of pride that I reflect upon the honor conferred in having been chosen to act in the capacity of president of this Association during the past year and thus be accorded the especial honor of presiding over this convention. And I say this earnestly and appreciably, fully realizing that the Association has treated me very generously, and particularly so considering that I am comparatively a young member. Then, too, I feel that the warm and sympathetic support that I have enjoyed at your hands is not without its sequel, but rather that it has endued me with such courage and confidence at this moment as will enable me to unhold, if only in a slight degree, the innate dignity of the office entrusted to my care.



D. R. MacBain, President, Master Mechanics' Association

I am extremely glad to see so fine a representation here today, denoting a delightful interest in the affairs of the Association, and particularly am I pleased to discern that the ladies—ever our loyal friends and sincere sympathizers—are with us in the usual goodly number. And I earnestly hope that all may find this convention not among the least interesting and enjoyable of those they have attended.

But while we rejoice in meeting again in this beautiful city, and in seeing many old, familiar faces and meeting new ones, may we not be unmindful of those who have met with us in the past, but who are not here today. Eight of the our members have passed to the Great Beyond during the year.

The papers to be read and discussed here are, perhaps, the most attractive and instructive of any that have been prepared for many years; this is especially true of the report of the Headlight Committee—the most nearly complete treatise of the kind in print,—and I sincerely hope that the attendance at the meetings will be such as to do ample justice to the subjects in hand.

During the past few years I have noticed a tendency on the part of the younger men of the Association to keep quiet during the discussions, permitting a few of the older members to do all of the talking. This is not good practice, and I am hopeful that all members, both young and old, will realize not only that it is their privilege, but their duty to talk freely on all subjects that might be brought before the convention. Let us this year have a real, old-fashioned Master Mechanics' convention; anyone who has anything to say should speak right up in "open meetin'" as it were. That is the purpose of the convention, and surely we cannot afford to miss the "young idea" at this time.

The supply companies, through their magnificent organization, the American Railway Suppy Men's Association, have prepared for our benefit a wonderful exhibit of modern tools and devices, and I am confident that this feature of the convention will be much appreciated and given the merited attention.

This is the ninth consecutive convention to convene in the "City by the Sea," and it is the desire of your president that it be the most pleasant and exhilarant of any of them. The entertaining features are many and varied, and may we all enjoy them to the limit good for mankind while we are here.

You will recall that, Past Presidents Bentley and Crawford, in their addresses to the conventions of 1912 and 1913, respectively, referred to the matter of consolidation; each suggested the advisability of shortening the period of time that we are kept away from our business. The matter of consolidating the two organizations seems to be more remote than it ever has been since the time consolidation was first advocated. Personally I am in accord with the change proposed by these gentlemen, and believe a reduction in the length of time away from business to be desirable. And Mr. Bentley's suggestion that the two associations meet in one week, devoting Tuesday and Wednesday to the meetings of the one association, and Friday and Saturday to the other, with the two associations meeting jointly on Thursday, seems to be a splendid idea, and I think the plant outlined should be given our earnest consideration. I should not like to see this Association lose its identity as such, for the consideration of matters pertaining to locomotive design, construction, maintenance and operation, and I know that you will agree with me when I say that this Association can be of far greater benefit in the handling of such subjects now than it has been at any other time in its history; for the problems of design, construction, maintenance, and operation are vastly more intricate to-day than ever before, and the necessity of an association of this kind is so apparent that it cannot reasonably be questioned by those who are in the least thoughtful.

The past year has made its mark in the way of legislation and regulation, but thus far, though materially adding to our burdens, we seem to have assimilated the new things, in part at least, and the prospects seem to be good that the new problems of the past year eventually will be solved without serious inconvenience. The question regarding the factor of safety applicable to locomotive boilers in service prior to January 1, 1912, was settled recently, and it is my belief that the agreement reached at the conference of the railroad representatives and the officers of the Government is equitable and should prove satisfactory to all concerned. On the whole, the spirit of cooperation manifested by the representatives of the railroads toward the representatives of the Federal and various state govern-

ments, in my opinion, has been of great value in associating us on a common, working plane, and I would urge that we all give to this particular phase of our business the necessary thought and co-operation in order that we may receive due recognition by the several governments of the fact that we are endeavoring to do our utmost in all things that are essential, regardless of whether we succeed at all times to their entire satisfaction.

In speaking of what might be accomplished along the line of decreased cost of operation and maintenance, there occur to me a few topics that we might dwell upon briefly and, provided we exercise a true spirit of co-operation and tolerance toward one another, rejecting narrowness and prejudice and forgetting our own individuality—which would seem to be the proper attitude of every member of this Association—then I can see no chance of our deliberations failing to effect such economies in the operation and maintenance of locomotives as would soon result in establishing an enviable reputation for this Association, marking it as one of the prime factors in the formation of a system of economy that would not be overlooked by our respective managements, and at the same time the Association would be considered a source of great assistance in the furtherance of betterment movements.

At the present time there are numerous things in relation to design, construction, maintenance and operation that are common to nearly every railroad on this continent, and therefore it would seem that there should be prevalent something in the nature of standard practices. And, in this connection, did it ever occur to you that we have about as many different practices as we have railroads? Perhaps not quite as many, but for the sake of argument we will let the assertion stand. Is it not probable that in all things pretaining to design, construction, maintenance and operation there must be at least a few items that this Association could pass upon authoritatively and make recommendations which, if put into practice when we return to our homes, would result in much good, not only to ourselves by reason of diminishing our troubles, but also to the respective companies we serve by reducing the cost of transportation? In all the things with which we have to cope in life the right and the wrong means to the end desired are recognized, and in the locomotive field there is, perhaps, greater likelihood of error in the selection of the right methods than there is in any other branch of railroad service. Why not, then, cast our individuality aside and endeavor to adopt and foster the right methods, and thereby fulfill the most important function of this Association? That is to say, that this Association, to retain its recognized position of prestige and usefulness, should divorce itself from the present plan of argument and, perhaps, from "Recommended Practice," and become the authoritative body ruling upon the subjects confronting its members, and then, by special circular, as well as in the annual report of proceedings, send out the "finished product" as a guide to its members? I fully realize, of course, that even this action would not be dominant in every particular case and entirely eliminate the idea of individual superiority and importance, but nevertheless it has been my experience that the men who really "do things" are those not blind to the fact that someone else might be in the right and they themselves in the wrong. I feel confident, that ultimately it will be found that nearly all of the men are broad-minded enough to discern the difference between the right and the wrong and will avail themselves of the benefit of the doubt.

F. F. Gaines, First Vice-President, M. M. Association

E. W. Pratt, Second Vice-President, M. M. Association

At the convention in this city in 1906, President Ball, in his annual address, told us of the increase in tractive effort during the period from 1896 to 1906. In the eight years intervening since that time wonderful changes have occurred in this respect. Comparing the average tractive effort of approximately 1000 locomotives operating on one of the important trunk lines, we find that since 1906 there has been an increase of 7,600 pounds, or 26.48 per cent. In face of this large increase, it is rather laughable to think that but a few years ago we were all pretty well agreed that the limits of size of locomotives, both passenger and freight, had been reached. Nor has the limit been reached yet; we are still going ahead; the evolution of the locomotive continues, and larger and more powerful units are being produced daily, as may be evinced from the large number of Mallet and Mikado engines now running in regular road service, performing work, in the way of efficiency and economy, far beyond the fondest expectation of the most optimistic of the men who introduced these types. And last, but not least, insofar as

size is concerned, comes the Triplex, the value of which is still to be determined.

It is gratifying to note that during the past five or six years more attention has been directed to the question of proper boiler proportions, and the effects of these changes have been very satisfactory in the production of unit efficiency, as well as in the reduction of haulage cost per ton mile. This I believe to be one of the wisest steps taken by the mechanical officers of the railroads in many years, and it is pleasing to note that the change is rather universal in the acquirement of new power. On older engines of quite modern design, where the boiler proportions are not quite as symmetrical as those on the power being built today, we have been able to increase the unit efficiency and decrease the fuel composition per ton mile by the introduction of modern devices, chief among these and by far the greatest benefactor being the superheater. This, I am sure, has afforded the means of taking the longest single step in advance in locomotive service that ever has been observed on this continent. During the past few years—only four years, I think, since the superheater was adopted generally by the railroads—we have overcome the difficulties attendant upon its use, and we now feel that we could not afford to get along without it. The question of lubrication and that of procuring suitable metals for packings and bushings, which at first appeared to be serious problems, now have become mere history for the most part, and those of us most skeptical in the beginning are now the strongest advocates of the superheater.

To demonstrate what can be accomplished in the way of reducing the amount of fuel consumed by locomotives equipped with the superheater, I should like to quote a few figures obtained from a test conducted to determine this point. In this test there were used three class "K" Pacific type locomotives—one a saturated steam engine, one built with a superheater, and one that had a superheater applied after having been built. The results of this test follow:

Engine Number	Kind	Direction	Pounds of Coal per Dynamometer H. P. Per Hour	Percent Saving per Dynamometer H. P. Per Hour
3441	Saturated	West	5.76	(Taken as Unity)
3433	Built with Superheater	"	3.97	31.1
3555	Equipped after Building	"	4.09	28.1
3441		East	5.65	(Taken as Unity)
3433		"	4.07	27.9
3555		"	3.91	30.0
3441	(Average East & West		5.71	(Taken as Unity)
3433	Bound)		4.02	29.6
3555			4.00	29.9

The wide extension in the use of the brick arch has proved to be another long stride toward unit efficiency and economy, and the change of sentiment that has taken place toward this device within the past five years affords a splendid exhibition of the healthiness of this Association in determining the factors that contribute to the general betterment of locomotive operation.

William Schlafge, Third Vice-President, M. M. Association

Angus Sinclair, Treasurer, M. M. Association

I have a few very interesting figures showing the results of a test conducted with a Mallet engine in its three different forms, namely, the original Mallet, the same engine with a superheater, and the same engine equipped with superheater and a brick arch. The figures represent the pounds of dry coal consumed per dynamometer horse power, and are given below:

Speed in Miles Per Hour	Original Mallet	Mallet with Superheater	Mallet with Superheater & Brick Arch
12.5	4.67	3.15	2.90
15.0	4.75	3.56	3.25
17.7	4.69	3.40	3.27
Average	4.70	3.37	3.14
Per cent. saving in fuel		28.3	33.2

There are many other items of betterment that I should like to review with you today, would time permit, each of which

has its own important function to perform in attaining the end desired—general betterment and economic results—and where these devices have been installed and properly maintained, together with good adjustment and general maintenance of the locomotive, the results are indeed gratifying. To verify this, we need but quote further from the records of the trunk line previously referred to, showing that during the past ten years these conditions have brought about a fairly good saving in the consumption of fuel alone. We have selected a summer and a winter month in the year 1903 to compare with a summer and a winter month in 1913, showing passenger and freight services separately.

Service	Month & Year	Coal Consumed	Per Cent. Saving
Passenger	July, 1903	332 lb.	
	July, 1913	239 lb.	
		93 lb.	28.01
Passenger	December, 1903	378 lb.	
	December, 1913	253 lb.	
		125 lb.	33.07
Freight	July, 1903	144 lb.	
	July, 1913	133 lb.	
		11 lb.	7.64
Freight	December, 1903	206 lb.	
	December, 1913	155 lb.	
		51 lb.	24.76

These figures are authentic and would seem to justify what has been done by our executives and the members of this Association as regards advancement, and surely such figures must expel from the minds of the stockholders all serious doubt as to the wisdom of the policy pursued.

ASSOCIATION BUSINESS

Secretary Taylor read his report, showing the membership at the present time to be as follows: Active, 979; Associate, 19, and Honorary, 48, making a total of 1,046. The report of the treasurer, Angus Sinclair, showed a cash balance on hand in current account of $941.51 The report was referred to an auditing committee made up of C. H. Rae (L. &. N.); J. F. De Voy (C., M. & St. P.), and W. J. Zollerton (C., R. I. & P.).

The secretary reported that there are three occupants of the Association scholarships at the Stevens Institute of Technology, and that the present occupant of the scholarship at Purdue University will graduate next year, so there will be a vacancy at that time. He stated that the executive committee has under consideration with Joseph T. Ryerson & Son a modification of their scholarship at Purdue, whereby there will probably be two scholarships instead of one.

The executive committee gave notice of the following proposed change in Article III, Section 5, of the constitution to read: "Members of the Association, active or associate, who have been in good standing not less than ten years, and who through age or other cause, cease to be actively engaged in the mechanical department of railway service, may, upon unanimous vote of the members present at the annual meeting, be elected life members. Th nominations must be made by the Executive Committee. The dues of the life members shall be remitted and they shall have all the privileges of active members, except that of voting.

"Members of the Association, active or associate, who have been in good standing, may, upon the unanimous vote of the members present at the annual meeting, be elected honorary members."

The secretary reported that at the meeting of the Executive Committee held Sunday evening the question was further considered; and that it was the sense of the executive committee that the honorary membership should be retained; and that there should be simply three classes of membership, active, associate and honorary. The suggestion of the executive committee is that this amendment be modified to read: "Members of the association active or associate, who have been in good standing not less than twenty years, and who, through age or other cause, cease to be actively engaged in the mechanical department of railway service, may, upon the unanimous vote of the members present at the annual meeting, be elected honorary members. The nominations must be made by the executive committee. The dues of the honorary members shall be remitted and they shall have all the privileges of active members, except that of voting." The modified amendment was adopted.

Mr. W. H. Corbett (Michigan Central) was granted the privileges of the floor as a representative of the Traveling Engineers' Association.

Secretary Taylor read the following communication, addressed to the officers of the association: "GENTLEMEN: On behalf of the International Railroad Master Blacksmiths' Association, we wish to thank you for the many courtesies we have received at your hands which have made possible our past development. However, being desirous of still further augmenting our numbers and increasing our usefulness, we very respectfully solicit your co-operation in aiding and encouraging your foreman blacksmiths to attend the convention of this association, which will meet in the city of Milwaukee, Wis., August 18, 19 and 20, 1914. We believe it to be the duty of every foreman to render his company the very best service possible, and we know of no means by which so much knowledge may be acquired as in the attendance upon these meetings. Believing you will give us your hearty support in this matter, and again thanking you, we are most respectfully yours, The International Railroad Master Blacksmiths' Association (signed by the committee.")

F. F. Gaines (C. of Ga.): I realize the immense amount of good it has done our foremen blacksmiths to attend these meetings, and I believe that all of us should try to encourage as many of our foremen as possible to attend whenever possible.

The President: There is not an association of the kind in railroad service that has done us more good than the blacksmiths have, and they are worthy in every way of our fullest co-operation and confidence.

The secretary read telegrams from E. J. Pearson, First Vice-President of the Missouri Pacific, and W. R. Scott, Vice-President of the Southern Pacific, urging that the conventions next year be held at San Francisco.

The following change in Section 3, Article 2, of the Constitution was proposed by the executive committee, to read: A representative member shall pay in addition to his personal dues as above, an amount for each additional vote to which he is entitled, as shall be determined each year by the executive committee, prorated upon the cost of conducting such tests as may be determined upon at each convention.

LOCOMOTIVE STOKERS

The committee believes most of the statements appearing in its last report have been borne out in practice, according to such observations as the additional year has permitted. No doubt, some erroneous conclusions have been drawn with reference to the capacity of the stoker, relative fuel consumption and economy, before fully weighing all operating conditions in train service. A truer value of the stoker and its range of usefulness and efficiency seems to be fully comprehended by those who have taken the time to make the necessary inquiries and investigation.

Where reference has been made to the use of run-of-mine coal in connection with the stoker, it should be understood that it generally means coal containing lumps not over 6 in. in size, though, strictly speaking, it is coal as it comes from the mines. Anything larger than 6 in. is apt to arch over the hopper, but this feature, it is claimed, can, and is, being improved.

The committee wishes to again refer to the difficulties surrounding the designing of a machine to suit present locomotive construction; not so much on account of the work to be performed, but the absence of choice as to arrangement, the absolute limitations of space, and the conditions under which such a machine must operate. It is believed that as time goes on, greater latitude will be given the designers, and consequently more will be accomplished, where it is preconceded that the stoker is to be a part of the locomotive. This should allow consideration being given to the working parts of the stoker along with the locomotive as a whole, and it is not improbable that when the design for the stoker is given equal consideration the locomotive will be constructed in many of its details so as to better suit, or be better adapted to, a stoker than now obtains where it is necessary to construct the stoker to suit exising designs.

Street Stoker.—The Street stoker, which is of the scatter type, and a type having the greatest number in service (totaling 418, with some 82 on order), as now designed, handles crushed or slack coal. Some of the earlier designs, however, were constructed to handle run-of-mine coal. A number of these stokers are still in operation on passenger engines on the Chesapeake & Ohio Railway. The tabulation shown as a part of this report is sufficient evidence that the engines so equipped are coming and going daily (many in pool service), performing the work expected of them, and the proper operation of the stokers with which the engines are equipped is left to the crews to which they are assigned.

Crawford Stoker.—Beyond the continued improvement in detail parts, the Crawford underfeed stoker seems to be adhering closely to its original principle of construction. The record shows that there are at present 301 in service, all applied to engines on the Pennsylvania Lines West of Pittsburgh, except two on the P. R. R. East of Pittsburgh. From all reports they are working satisfactorily. The machine, as previously described, handles run-of-mine coal, producing its best results

using the higher volatile products. The report from the Pennsylvania Company is to the effect that they are closely observing the everyday performance of the stokers in service, so as to ascertain under which the highest efficiency is obtained, and incidentally are educating men to handle and control them to the best advantage.

Hanna Stoker.—The Hanna stoker is another of the scatter type, but handles run-of-mine coal, as described in detail in last year's report. It continues to perform its work satisfactorily, according to reports.

Standard Stoker.—The committee's last report mentioned all stokers concerning the operation of which information had been secured. Since that time some tests of the Standard stoker have been made on the New York Central in heavy freight service, and the reports so far seem to be quite promising. The company manufacturing the stoker, like other designers, seems to be satisfied that they are working along the right lines, and such may be the case, but time and trial only can determine if they are right. A special feature claimed for the stoker is the elimination of all parts from the engine cab and deck, and the use of run-of-mine coal without previous treatment or selection. The coal is reduced to the required size by an arrangement of the feeding screw, thus eliminating the necessity of a separate crusher. As the coal gravitates to the horizontal screws it is delivered to a point about the center of the firebox—but at the back end—where another screw, in a vertical position, elevates the fuel to a sufficient height, where it is blown by steam over the fire bed. The machine is actuated by a turbine engine, which is also a departure from the conventional lines followed in other designs. A second stoker of the Standard type has been put on a Mallet engine in service on the New York Central, and three more have been secured for experimental purposes on the Norfolk & Western Railway. Two of the latter machines will be applied to heavy freight engines of the 4-8-0 type, and the third to a heavy passenger engine. The Standard stoker, like the Hanna and Crawford, differs from the Street in that it handles run-of-mine coal, whereas the Street, as now constructed, requires prepared or slack fuel.

Ayers Stoker.—Within the past year some very interesting work has been done by A. R. Ayers, general mechanical engineer, New York Central Lines, toward the utilization of the chain grate. The committee is not familiar with the details of the design, nor the progress thus far made, but understands it is not quite ready for application. The idea indeed is interesting, and is a principle the committee believes well worth exploiting. The Standard and Ayers, if we may so designate the latter, seem to represent the most prominent work in the stoker field during the past year.

Gee Stoker.—But one stoker of the Gee design has been built to date. It is still in service on a Class H-6 (2-8-0 type) locomotive on the P. R. R. East of Pittsburgh, and is reported as giving good results. It is still considered in an experimental stage.

Elvin Stoker.—With the construction of a full-size working model of the Elvin stoker, which is now ready for application, a distinctly new principle is offered. While it properly belongs to the "scatter" or "overfeed" group, it may be referred to as the shovel type in contradistinction to the rest. The machine is attached to a casting similar to and is bolted to the back head of the boiler—the same manner as the firedoor front. It is made up of two shovels, one operating to the right and the other to the left; under full control, distributing coal regularly and evenly over the bed of the fire, as might be expected under expert hand firing. The drum, or stoker mechanism, operates at 20 r.p.m. when shoveling 12,000 lb. of coal per hour. The operation is entirely mechanical, no steam being used in distributing the coal.

Rait Stoker.—The Rait stoker is a patent of George B. Rait, of Minneapolis. The committee has not seen any working drawings, but understands from the inventor that most of the machinery is below the deck of the cab. It is also mentioned as an interesting feature that it can be handled as either an underfeed or a scatter type. As yet there are none in operation.

The Norfolk & Western Railway submits the following performance figures for the Street stoker:

*All failures chargeable to stokers:	
Total number of machinery failures in fair service	43
Total number of failures due to flaws and defects in machinery	4
Total number of failures due to machine becoming clogged with foreign matter	31
Total number of shop or bad-workmanship failures	19
Total number of crew failures, or failures due to improper handling, resulting in low steam	48
Total number of failures due to improper lubrication as a lack of attention	20
Total failures	165
Total mileage made by engines equipped with stokers	2,296,803
Total stoker failures as above	165
Miles per stoker failure	13,920
Total cost for labor and material chargeable to stokers	$12,179.22
Cost of stoker repairs per 100 miles, cents	.53

Engines 1303 and 1311 have not as yet had a stoker failure charged to them, having made 36,089 miles and 35,778 miles, respectively, since the engines were put in service new in April, 1912.

The Baltimore & Ohio reports that the Street stokers in service on that road are making 44,300 miles per failure chargeable to the stoker proper. It may be of interest to mention in connection with the apparent difference in the figures submitted by the Baltimore & Ohio and the Norfolk & Western showing mileage per stoker failure, that the Baltimore & Ohio figures are computed on the basis of the number of machinery failures in fair service and does not include delays caused by the stoker not being properly operated by the engine crews. On the same basis, as can be quickly seen by referring to the tabulation, the mileage per failure on the Norfolk & Western would be equal to 53,414 miles, which is very close.

The following data are submitted by the Pennsylvania Lines West of Pittsburgh, giving some interesting information in connection with the performance of the Crawford stoker, including *all* trips of all stokers from the experimental installation to this date:

	As Reported Jan., 1913	As Reported Jan., 1914
Total number of trips	26 693	98 181
Number of trips—100 per cent.	16 445	55 913
Number of trips— 99 per cent.	262	335
Number of trips— 98 per cent.	402	723
Number of trips—95-98 per cent.	1 367	3 865
Number of trips—90-95 per cent.	1 577	5 352
Number of trips—85-90 per cent.	560	1 861
Number of trips—80-85 per cent.	715	2 963
Number of trips—75-80 per cent.	962	4 086
Number of trips—70-75 per cent.	305	1 306
Number of trips below 70	4 098	21 787

The Norfolk & Western submits the following data for the Hanna stoker:

Put in Service, February 11, 1914.

Number of days in service	48
Number of trips	37
Number of 100 per cent. or successful trips	32, or 86 per cent.
Number of failures on road requiring hand firing for a portion or completion of trip to be made pending repairs to be made	5

During the year 1912 there were 165 Street stokers in operation. During the year 1913 there were 253 additional stokers installed, making a total of 418 in operation. They are distributed as follows:

ROAD	Consolidation	Mallet	Mikado	Mt. Type pass	Decapod	Centipede	Pac. pass	Total
L. S. & M. S.		3						3
N. & W.	2	90						92
C. & O.		14	50	3			6	73
B. & O.	1	24	161		1			193
Virginian		6	1					7
B. R. & P.		5	1					6
H. V.			17					17
A. T. & S. F.		1						1
D. M. & N.		8						8
E. P. & S. W.	1		5					6
C. B. & Q.			1		12			13
Erie						1		1
Total	4	155	236	3	13	1	6	418

During the year 1912 the Penna. Lines West of Pittsburgh had 153 double underfeed Crawford stokers in operation. The P. R. R. East of Pittsburgh had 2, making a total of 146. During the year 1913, 155 additional stokers were applied, making a total of 301:

Type of Stoker	Class of Locomotives	As Reported in Jan., 1913	As Reported in Jan., 1914
12	K2	1	1
12	K2as	26	26
12	K3s		30
13	H8c	10	10
13	H8cs	1	1
14	H6a	5	5
15	H6a-b	20	20
16	H6a	1	1
17	H8c	1	1
19	B29	1	1
22	H8c	54	54
22	H8cs	32	32
22	H10s		110
23	H6a-b	1	2
25	K2		4
25	K2as	2	3
Total		155	301

COMPENDIUM

Type of Stoker	No. of Stokers in Service	No. of Stokers on Order
Street	418	82
Crawford	301	....
Hanna	3	21
Standard	2	3
Gee	1	....
Ayers	1	....

During the past year opportunities have been afforded to observe a much larger number of stokers in service, many of them working in pool runs, which rather strengthens the belief that they are capable of going along, faring under the usual average attention given a locomotive, without developing prominent or serious defects that result in materially increasing terminal turning time. They require attention and repairs, but the cost figures are not excessive, considering the stage of development through which they are passing. Alterations are now in progress looking toward stronger and more durable machines, which should in turn favorably affect the cost of maintenance.

It is noteworthy that when the demands upon the boiler are fairly uniform, permitting a regular feed of coal, the operation of the stoker practically takes care of itself, but, in the absence of automatic manipulation, manual control does not always result in efficient regulation of the fire; on the contrary, the boiler, if anything, is allowed to blow off more than necessary, not only under working conditions, but quite freely when the demands are reduced, and when the engine is not using steam, carrying with it some waste of fuel, due, however, to want of attention. Then, again, there is some tendency, through neglect, to allow the fire to get low while standing on the road, making rebuilding necessary; still with the stoker the fire is readily revived, and little, if any, time is lost thereby.

It is still a mooted question, as to whether it is economical to use run-of-mine or screened coal. Both schemes are worthy of consideration, depending upon local conditions, and in the same way that it is necessary a road contemplating the use of stokers can only work out the advantages to be gained after taking into consideration the physical character of the road, the size of engines, and the tonnage now being handled, it should ascertain whether upon taking into account all local conditions it is more profitable to use the screened or run-of-mine coal.

As for fuel consumption, it has been pretty clearly shown that the amount of coal used by the stoker (as to some extent obtains in hand firing) largely depends upon the physical character of fuel rather than the heat value, so long as the latter is within a reasonable range.

The year's experience seems to give color to the belief that the stoker is not necessarily a coal-saving device, but that its advantages tend in other directions. Dynamometer tests have shown that the capacity of the locomotive is increased, and according to further reports made by the Pennsylvania an increase approximating 5 per cent. in trainload with the Crawford stoker for an equal amount of fuel hand-fired has been obtained. The Baltimore & Ohio reports an increase in train tonnage from 5 to 10 per cent. In both, however, it should be remembered that the differences indicating increased capacity were largely dependent upon local conditions. The Hocking Valley advises, in connection with the Street stoker, that they are using fuel known in the Hocking Valley district as "coarse slack." It is coal that passes through a ¾-in. mesh screen. Their fuel record showing consumption of coal per engine per 1,000 miles does not indicate there has been any reduction in fuel per 1,000 ton-miles, but that the grade of coal used is purchased at about 40 per cent. less than run-of-mine.

In tests made on the Norfolk & Western Railway it was found with one of the scatter-type stokers that there was a considerable increase in coal consumption using Pocahontas slack as compared with Pocahontas run-of-mine hand-fired. The difference in quantity of coal consumed as between screened coal stoker-fired and run-of-mine hand-fired was found to diminish as the physical character approached the run-of-mine, or a products containing a less amount of fine material.

With the higher volatile coals containing a smaller amount of fine product, the consumption of fuel as between hand-fired and stoker-fired should be very close. It also seems evident that though the consumption increases as the coal becomes finer in character, the stoker is better able to maintain steam with it than might be secured on an average hand-fired.

With reference to the emission of smoke: The committee has not had the opportunity to make extensive investigations, but has received reports that when the feeds are not forced beyond the limits of complete combustion, the reduction in smoke is longer maintained with the underfeed than with the scatter types, on account of the fuel being delivered up through the bed of the fire as combustion progresses, under conditions of service and character of fuel suitable to their present stage of development.

It is understood that the New York Central have made some investigations in connection with the use of pulverized fuel on switching locomotives, and it is still investigating the subject, but up to the present time it is quite experimental. The Pennsylvania has also given it some consideration, but advise they have nothing of interest to offer.

The report is signed by:—A. Kearney, (N. & W.), chairman; M. A. Kinney, (H. V.); J. H. Tinker, (C. & E. I.); I. B. Thomas, (Nor. Cent.), and J. T. Carroll, (B. & O.).

DISCUSSION

J. T. Carroll (B. & O.): The report shows that we have 193 of the stokers in service, 161 of these being on our standard Mikado road locomotive. The tonnage procured from these engines, over the same engines hand-fired, ranges from five to ten per cent. greater according to the division on which they are operated. On a certain grade, 0.3 per cent., the increased tonnage runs practically to 8 per cent. Another thing which we noticed last summer during the hot weather on the Cumberland division, was that while it was almost impossible two years ago to keep good firemen on these same engines when they were hand-fired, that last summer we had very little trouble; in fact, we lost very few firemen. We find one good way of arranging the matter is to have the men run the fast freights one way, then relieve the crew for one hour, and then run them back on a slow freight, which we are able to do within sixteen hours. We also started last winter running one of these Mikado engines on passenger trains over the mountains—that is, from Cumberland to Grafton. Seven cars on the seventeen-mile grade is about the limit which we can haul with the Pacific type engine, and on those trains, where we have to run eight and nine cars, it made it necessary for us to double head the train. The Mikado engines have been running very successfully, hauling eight and nine cars without a helper. In the case of the Mallet engines we have had practically no trouble whatever with them. Previous to the application of a stoker it was very hard to get them fired properly. We have recently placed in service a 2-10-2 simple superheater engine weighing 335,000 lb. on drivers. This engine has 30 in. x 32 in. cylinders and 58 in. drivers giving a tractive effort of 84,000 lbs. The grades on which it operates are from 2 to 2.4 per cent. and 17 miles long. Last week we started to run some tests, and I understand that the engine is developing more than 84,000 tractive power.

Geo. L. Fowler, (Ry. Age Gaz.): One of the impressions which I got from riding the stoker engine is that it is no place for a lazy fireman—on a well-designed stoker engine, he will get up on the fireman's box, start his stoker to run, and then begin to take things easy generally, saving himself from all the work he can, and he will burn a good deal more coal than he would have burned if the engine had to be fired by hand. In regard to the actual work that the stoker can do, they maintain steam pressure, to be sure, at considerable expense, a good many of them, but it looks to me as though the stoker was getting down to business, and going to do the work really economically. Many people say—"The stoker burns more coal than a hand-fired engine does." To be sure, it does, but it does more work, and it allows us to increase the load on the engine. I had occasion to ride on a Mallet engine with cylinders 23 in. and 35 in. by 32 in. We were back of a long train-pushing, running about 10 m. p. h. The reverse lever was in the corner, the throttle valve was wide open, and the engine was doing all it could. One injector was insufficient to maintain the water level. The engineer ran his water until he was nearly down to the bottom of the glass, and then deliberately opened the other injector, and kept it on until he had filled his boiler away up to the top of the glass, and the steam gage never moved. At the end of the trip the fire was the most beautiful I have ever seen in an engine. The fireman did not let that stoker alone for two consecutive minutes on that whole run.

In a number of cases, where there were double-headers, with one fired by stoker and the other fired by hand, there was a very marked difference in the smoke production of the two engines. The stoker-fired engine would be running along one and a half to two per cent. according to the Ringlemann chart, and the hand-fired engine would be 2, 3 and 3½ per cent., and even up to four per cent. When the speed gets up to 25, 30 and 35 m. p. h., that smoke production drops off until it would not be more than 0.5 per cent. according to the Ringlemann chart. That is for the scattered type stokers, for the underfed stoker, there is practically very little smoke production at all.

C. H. Hogan (N. Y. C. Lines): We have two locomotives equipped with the Standard stoker, one Consolidated and one a Mallet. They are not on the district over which I have supervision, but from the reports received from Mr. Friese, and those who have been following up the stoker, I understand that their performance is beyond the expectation

of every one. We are equipping one locomotive for the purpose of using powdered fuel wholly, but the locomotive is not yet ready for service.

C. F. Street (Locomotive Stoker Co.): We have made practically no change in the machines during the past year. We have at the present time in the process of manufacture and going into service about 75 additional machines. There is one point which I think would interest the members, and that is the different character of coal which we are called upon to use; that is one of the first questions which comes up when the railroad man begins to talk stoker—"Can you use our coal?" I can make the broad statement that we have never been offered a coal which couldn't be used successfully with ordinary firing which we could not use with the stokers with equally good results. In some cases, with poorer grades of coal, we have been able to obtain better results than can be obtained with ordinary hand-fired engines. In addition to the bituminous coal, we are now successfully firing the locomotive with anthracite. We have made some trips with a pure anthracite, but most of the trips have been made with a combination of anthracite and bituminous. The distribution with the mixture of anthracite and bituminous is more difficult than with a straight bituminous coal. To give you some idea of the different kinds of coal we are using we are firing on the Norfolk & Western with Thacker slack, Pocohontas nut, Pocohontas slack, and Thacker nut. On the Baltimore & Ohio we are using No. 2 soft and No. 1 gas slack. On the Pere Marquette we are using No. 3 Ohio nut. On the Hocking Valley we are using several kinds of Ohio coal. On the C. B. & Q. we are using several Illinois screenings, at a very much less cost than the run of mine coal which they use for hand-firing. On the Great Northern they are using a semi-ligmite, one of the most difficult coals to use, but we are using it successfully. On the Delaware & Hudson we are using No. 2 buckwheat, and Bird's-eye anthracite, mixed, about 25 per cent. of the bituminous and 75 per cent. of the anthracite. We are also using upwards of 20 different kinds of bituminous coal on the Chesapeake & Ohio.

I have just had a letter within the past week from the El Paso & Southwestern, stating that they had put five stokers in service and have just completed an aggregate of 90,000 miles, and that they had at the end of that period one case of trouble. These five new locomotives went into service on the road where we had no representative to instruct the men in handling the machine. The stoker is a machine which does a machine-firing job. When the fireman goes over the road with the stoker, he is doing his job pretty nearly right. When he goes over the road with the ordinary fired locomotive you all know that he can violate every rule of correct firing and still get his train over the road; he cannot do it with the stoker. If the stoker is not worked in the right manner, he will have a locomotive failure.

D. F. Crawford (Penna. Lines): As to whether or not it will be possible to fire the locomotive with the stoker, there is no longer any question. Perhaps the best evidence I can give you is to read a memorandum which was left upon my desk the day I left, by one of the division superintendents:—"Seven hundred and eighty-seven trips, twenty engines in a pool, all handled by enginemen in a pool, 94 per cent. stoker-fired." That is the performance in one division for a month. The stokers which we are using have made now considerably over 100,000 trips. Fifteen per cent. of these can be marked down as failures of the stoker. We feel that the underfed stoker has the same promise of success that the other type has. As to the amount of fuel used by the stoker it depends entirely on the man who handles it. He can put in more coal than is necessary, or he can put in the proper amount. One of the tests made on the testing plant at Altoona, the bulletin of which was recently published, gives a very good reason for overfiring a locomotive. My recollection is on that test, the locomotive was so operated as to require 3,000 lb. of coal per hour, supplied by a skilled testing plant fireman. I think during the two hours' test about 100 lb. of steam was blown off the safety valve. The same locomotive, doing the same work, was supplied with 3,500 lb. of coal per hour, and somewhat over 1,000 lb. of steam was blown off the safety valve. In both cases the engine steamed well and there was ample steam for work. Then the test was repeated, with the same men in charge, supplying 2,500 lb. of coal, or about that—I am speaking from memory—and there was what might be called a steam failure, in other words, the tendency is to overfire a locomotive and keep steam up.

We all have power statistics, so called, ton mile data, pounds of coal per ton mile, gross ton miles or regular ton miles, etc.; but they are of practically no value in comparing the performance of one road with another, comparing one train with another. I have taken the trouble to plot the amount of coal consumed per ton mile, against the tons of lading, and if any of you will do that, I think you will find the pounds of coal per 1000 ton mile is about as misleading a statement as can be made. The only way to determine the relative coal consumption of the locomotive, whether it is equipped with the stoker or not, is through a long series of observations, and on trains of the same weight. There is a decided field for the locomotive stoker. I do not think any locomotive is paying its way unless it is burning about 100 lb. of coal per square foot in the grate all the time; more if possible. I believe on long runs, in warm weather especially, the stoker will be found a great value.

All of the stokers which have been built on our lines have been applied to the locomotives, that is, there has been no modification made in respect to the locomotives themselves. We think the day is coming when the locomotive designer will admit the existence of the stoker and prepare that portion of the locomotive and tender for the proper reception of the stoker.

The committee says: "It should be understood that run-of-mine coal generally means coal containing lumps not over 6 in. in size." That is not so in the State of Pennsylvania. The lumps are very much larger, and the stoker which we have been using handles the coal as it comes from the mine. The fact exists that the coal does arch over at times, but on comparatively few trips, and the trips where it makes any trouble in arching over is in passenger service. The locomotives have been provided with an arch mover which is entirely satisfactory, and we are prepared to handle any size of coal as it comes from the mines.

E. A. Averill, (Standard Stoker Co.): I can say that my experience with the stoker operation, both the one with which I am connected and some of the others, is pretty well illustrated by part of Mr. Fowler's remarks, where he stated that the engineer loses his interest in the steam gage. That is rather striking, and you all know that the engineer with a hand-fired engine operates his locomotive in accordance with the operations of the fireman. His eyes are constantly, or at any rate, frequently, on the steam gage. In the case of a stoker operated engine, he learns that the gage is always at the same point. Then he begins to take interest in how much power he can get out of his locomotive. The results are, in some cases, rather surprising—you will have more power in that machine than you have imagined it possible to get out of it. They haul more cars and go over the road much faster. I am not in entire agreement with what Mr. Fowler had to say about the lazy fireman. My experience has been that if the fireman is intelligent and operates the machine intelligently, he can be a pretty lazy man, and still do just as much good work as it is possible to do. So far as his starting the stoker going and allowing it to run, through laziness, and thus waste the coal, that is possible. My experience is, however, if he puts any more coal than is needed into the firebox, the safety valve will open and blow off steam, and immediately notify the engineer what is taking place. He can easily set the machine to supply the coal for the steam being used. I never think of limiting the lump of coal to six inches, when I think of run-of-mine coal, and most other people do not. It seems to me that run-of-mine coal is coal which is not previously prepared or screened, and that would, possibly, more accurately describe what is generally meant by that term.

T. R. Cook, (Penna. Lines): On one of our low-grade divisions, where we are hauling heavy trains to and from the Lake, we realize to a great extent the benefit of the stoker in hiring and retaining firemen. Previously to last year, on this division, is was very hard to get firemen to handle the locomotives, and handle them successfully with the lading we desired to carry. Last summer we had no difficulty whatever on the stoker-fired engine. Relative to the smoke situation, in Chicago they are after us pretty hard regarding the smoke nuisance. We have 17 locomotives in heavy transfer service, and with the work they have to do, they are operating practically smokeless. Our experience has been that the man who does the least work is not the lazy man, but the man who is anxious enough to perform his job well, so that he goes around and finds out what is doing. We had one fireman who stated that he had not had the firebox door open for two weeks in succession. He would start off from the station in the morning, see that his fire was in good shape, shut the door of the firebox, get up on his seat, and all he would do was to operate the valves controlling the stoker. He knew about how much coal the fire required, and how it should be fed to the fire to keep a good fire.

REVISION OF STANDARDS AND RECOMMENDED PRACTICE.

[EDITOR'S NOTE: In abstracting this report a number of items have been left out concerning corrections in the drawings in connection with the Standard and Recommended Practices, which were ordered corrected by the committee. Items have

also been omitted concerning suggestions which were not approved.]

CASTLE NUTS. (STANDARD.)
Page 485. Sheet M. M. 15.

At the 1913 convention the subject was presented considering the modification of the table of standard proportion of castle nuts in order to provide for steel nuts with the height of the U. S. Standard for rough nuts. The details of this were referred by the executive committee to this committee.

Laboratory tests were made in more or less detail of steel castle nuts made in full proportions to agree with the present standards excepting in the height of the nut, which was made the same as the U. S. Standard rough nuts. Also the threading for the bolts was extended to the top of the castellation.

The nuts were screwed onto mild-steel bolts and the combination pulled to destruction. In the majority of the cases the bolt failed in the thread just below the nut, and in cases where the nut was at all originally too loose on the bolt, the threads on the bolt usually stripped.

The results of these tests have been briefly summarized and are shown in the following table, from which it is seen that for working pressures ordinarily used, these steel nuts have ample proportions.

Nominal Diam. Bolt.	Nominal Area Bottom Thread Sq. In.	Total Strain—Lbs. Estimated.		Actual Strain.		
		@7 000 Lbs.	@10 000 Lbs.	Min.	Max.	Average.
⅝"	.125	875	1 250	8 100	8 640	8 370
¾"	.3	2 100	3 000	20 030	21 000	20 515
⅞"	.42	2 940	4 200	24 830	29 750	27 760
1 "	.55	3 850	5 500	30 850	42 370	36 600
1⅛"	.69	4 830	6 900	38 910	52 210	47 000
1¼"	.78	5 460	7 800	49 550	68 850	59 000
1½"	1.28	8 960	12 800	72 910	78 600	75 260
2 "	2.3	16 190	23 000	....	141 950	....
2½"	3.7	25 900	37 000	....	198 400	....

Taking as a basis the rough diameter of U. S. Standard nuts, the rough thickness of U. S. Standard nuts for sizes 1 in. and over and the present thickness of thin castle nuts for sizes ⅞ in. and smaller; the proportions of the present slots for thick and thin castle nuts; extending the bolt-threading to the end of the bolt to obtain the full benefit of the threading in the castellation and maintaining the present sizes of cotter and taper pins and holes, the committee presents the accompanying table of proportions for consideration:

SPECIFICATIONS FOR STEEL TIRES. (RECOMMENDED PRACTICE.)
Pages 486-489.

A member calls attention to the fact that in the physical test of steel-tire specimens the elongation is to be measured in 4 in. and that general practice and the American Society for Testing Materials use 2 in. He further recommends the following of the practice of the American Society for Testing Materials.

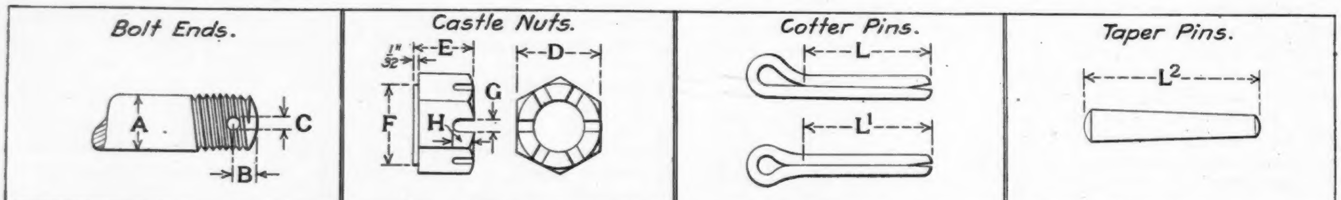
The committee concurs in this recommendation and suggests

W. E. Dunham
Chairman, Committee on Revision of Standards and Recommended Practice

changing the table in Section 7, on page 487, to read as follows:

Class	Tensile Strength Lbs. per Sq. In.	Elongation per cent. in 2 Inches.	Reduction in Area per cent.
(A)	105 000	12	16
(B)	115 000	10	14
(C)	125 000	8	12

(D) The elasticity shall be at least 50 per cent. of the tensile strength.



Bolt Ends. A	B	C	Castle Nuts. Standard D	No. Thds	E	F	G	H	Thin E	No. Thds	Cotter Pins. Nominal Diameter	L	L1	Taper Pins. Number	L2
1/2	3/8	3/16	7/8	13	3/4	13/16	1/4	3/8			3/16	7/8	1 1/4	2	1 1/4
5/8	"	"	1 1/16	11	13/16	1	"	"			"	1	1 1/2	"	"
3/4	"	"	1 1/4	10	7/8	1 3/16	"	"			"	1 1/4	1 3/4	"	1 1/2
7/8	7/16	1/4	1 7/16	9	15/16	1 3/8	5/16	7/16			1/4	1 1/2	2	4	1 3/4
1	"	"	1 5/8	8	1	1 9/16	"	"			"	"	"	"	2
1 1/8	1/2	5/16	1 13/16	7	1 1/8	1 3/4	3/8	1/2	1 1/16	8	5/16	1 3/4	2 1/4	6	2 1/4
1 1/4	"	"	2	7	1 1/4	1 15/16	"	"	1 1/8	"	"	"	2 1/2	"	"
1 3/8	"	"	2 3/16	6	1 3/8	2 1/8	"	"	1 3/16	"	"	2	"	"	2 1/2
1 1/2	"	"	2 3/8	6	1 1/2	2 5/16	"	"	1 1/4	"	"	"	3	"	2 3/4
1 5/8	"	"	2 9/16	5 1/2	1 5/8	2 1/2	"	"	1 5/16	"	"	"	"	"	3
1 3/4	9/16	3/8	2 3/4	5	1 3/4	2 11/16	7/16	9/16	"	"	3/8	2 1/2	3 1/2	"	3 1/4
1 7/8	"	"	2 15/16	5	1 7/8	2 7/8	"	"	1 3/8	"	"	"	"	"	"
2	5/8	"	3 1/8	4 1/2	2	3 1/16	"	"	1 3/8	"	"	3	"	7	3 1/2
2 1/4	"	"	3 1/2	4 1/2	2 1/4	3 7/16	"	"	1 7/16	"	"	"	4	"	3 3/4
2 1/2	11/16	1/2	3 7/8	4	2 1/2	3 13/16	9/16	11/16	1 1/2	"	1/2	3 1/2	5	8	4 1/2
2 3/4	"	"	4 1/4	4	2 3/4	4 3/16	"	"	1 9/16	"	"	"	"	"	"
3	13/16	"	4 5/8	3 1/2	3	4 9/16	5/8	3/4	1 5/8	"	"	4	"	9	5
3 1/4	"	"	5	3 1/2	3 1/4	4 15/16	"	"	1 11/16	6	"	5	6	"	5 1/4
3 1/2	"	"	5 3/8	3 3/4	3 1/2	5 5/16	"	"	1 3/4	"	"	"	"	"	5 3/4

All dimensions given for finished sizes. One-sixteenth inch to be added to finished dimensions of nuts for rough sizes.

Standard Castle Nuts and Details

JOURNAL-BOX WEDGES. (STANDARD.)

5 by 9 in. Journal. Sheets M. M. 9 and 10.
5½ by 10 in. Journal. Sheets M. M. 12 and 13.

A member suggests that the wedges should have the downward projecting lips shown at the front of those wedges, the same as are shown for the 4½ by 8 in. on Sheet M. M. 7.

The committee concurs and secretary is instructed to correct the drawings.

3¾ by 7 in. Journal. Sheet M. M. 4.
4¼ by 8 in. Journal. Sheet M. M. 7.
5 by 9 in. Journal. Sheet M. M. 10.
5½ by 10 in. Journal. Sheet M. M. 13.

A member recommends that the use of solid wedges only be permitted and the note allowing the use of skeleton wedges be omitted.

The committee concurs in this suggestion only so far as 5 by 9 in. and 5½ by 10 in. journals are concerned.

SPECIFICATION FOR CAST-IRON WHEELS. (RECOMMENDED PRACTICE.)

Pages 498-504. Sheets M. M.—E, F and G.

A member calls attention to the title and note under cut on Sheet E, advising that in order to agree with the M. C. B. Specifications for Cast-iron Wheels, and also to conform to the loading for which the 4¼ by 8 in. journal axle was designed, this should read "maximum gross weight not to exceed 95,000 lb.," instead of "112,000 lb."

The same correction is suggested for the title of the specifications, page 498, and the table of weights on page 500.

The committee concurs and recommends the suggested correction.

GAGE FOR MEASURING STEEL WHEELS. (RECOMMENDED PRACTICE.)

Page 511. Sheet M. M.—C.

A member suggests adding the words "to remove in order" between the words "necessary" and "to restore."

The committee concurs and the secretary is instructed to add this to the text.

CHECKING FORMULAE FOR MAIN AND SIDE RODS.
(RECOMMENDED PRACTICE.)

Pages 527-530.

A member suggests advancing this to Standard. The committee concurs in this recommendation.

NEW BUSINESS.

A member suggests that the M. C. B. journal box and contained parts for 6 in. by 11 in. journal axles be adopted as Recommended Practices.

The committee concurs in the suggestion.

Under instructions, your committee was to rearrange all specifications for material to conform to the outline adopted by the Master Car Builders' Association. Believing that all specifications should at the same time be revised to agree with the latest recommendations of the Master Car Builders' Association and the American Society for Testing Materials, especially the latter, your committee would refer the matter to the convention for further instructions.

The report is signed by:—W. E. Dunham, (C. & N. W.), chairman; R. B. Kendig, (N. Y. C.); M. H. Haig, (A., T. & S. F.); A. G. Trumbull, (Erie), and C. D. Young, (Penna.).

The report was referred to letter ballot, with the exception of the sections on maximum and minimum flange-thickness gauge and rearrangement of specifications, which were referred back to the committee for further action next year.

SAFETY APPLIANCES

D. R. McBain: I wish to state, as chairman of this committee, that no written report was prepared. Some recent statistics which I have had an opportunity to see indicate that the work is practically completed, and that the progress in the equipping of the locomotives has been very satisfactory. There are, however, a very few that are not up to standard, and I wish to recommend that every one who knows these appliances are not up to standard, correct them as soon as possible. (The report was received and approved.)

FLANGE AND SCREW COUPLINGS FOR INJECTORS

BY O. M. FOSTER,

Master Mechanic, Lake Shore & Michigan Southern, Collinwood, Ohio.

Threaded Couplings.—The arrangement of injector pipes generally employed in this country embodies the use of a copper pipe between the turret and the steam connection on the injector body, a wrought-iron or copper pipe between the delivery connection of the injector and the boiler check, and a wrought-iron pipe or cast-iron goose neck between

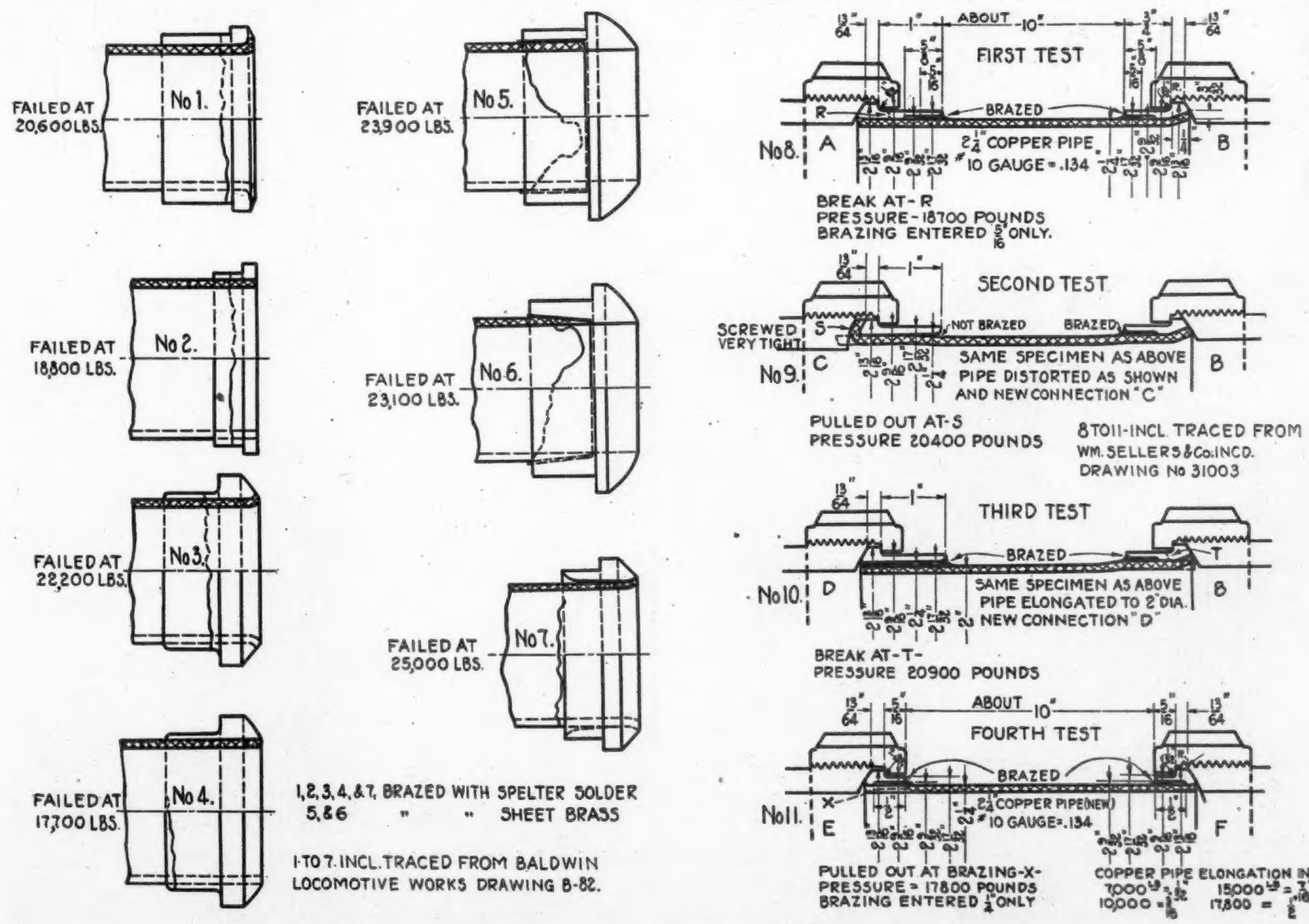
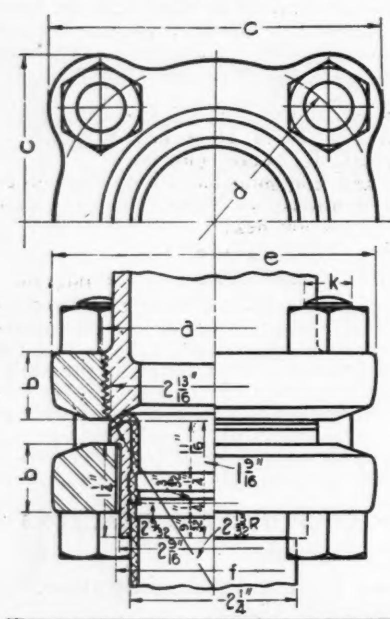


Fig. 1—Test of Brazed Connections for Injector Manufacturers' Committee

the tank-hose coupling and the suction (or water) connection on the injector body. It has been customary also to use on the ends of copper pipe a ball joint brazing ring and on the ends of iron pipe a pipe union or ball joint nipple, in either case completing the connection by the use of a threaded coupling nut.

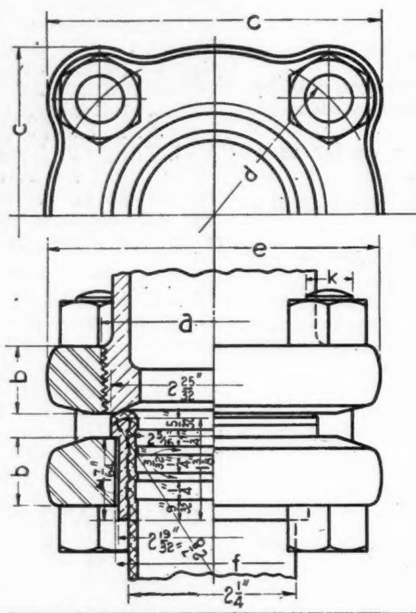
Tests on brazed connections were made during 1913 at the instance of a committee of injector manufacturers, S. L. Kneass, chairman. The nature and results of these tests are illustrated in Fig. 1, Nos. 1 to 7, inclusive, illustrate a variety of brazed connections which were tested on a Riehle testing machine at the Baldwin Locomotive Works. The brazing

STYLE-V.



SIZE OF PIPE IRON	SIZE OF PIPE COPPER	a	THDS PER IN	b	c	d	e	f	k
1 1/4-1 1/2	1 1/2-1 3/4	2.362	10	25/32	3 15/16	3 11/16	3 11/16	2 1/32	5/8
2	2	2.826	10	25/32	4 3/8	4 1/4	4 1/4	2 13/32	5/8
1 1/2-2	1 3/4-2-2 1/4	3.011	8	29/32	4 1/2	4 3/8	4 3/8	2 19/32	5/8
2	2 1/4	3.031	10	29/32	4 1/2	4 3/8	4 3/8	2 19/32	5/8
2 1/2	2 1/2-2 3/4	3.472	8	15/16	5 1/16	5	5	3 3/32	5/8
2 1/2	2 3/4	3.472	8	15/16	5 1/16	5	5	3 5/32	5/8
3	2 3/4	3.960	10	1 1/32	5 11/16	5 3/4	5 3/4	3 5/32	3/4
3	3 1/4	4.125	8	1 1/32	5 11/16	5 3/4	5 3/4	3 21/32	3/4

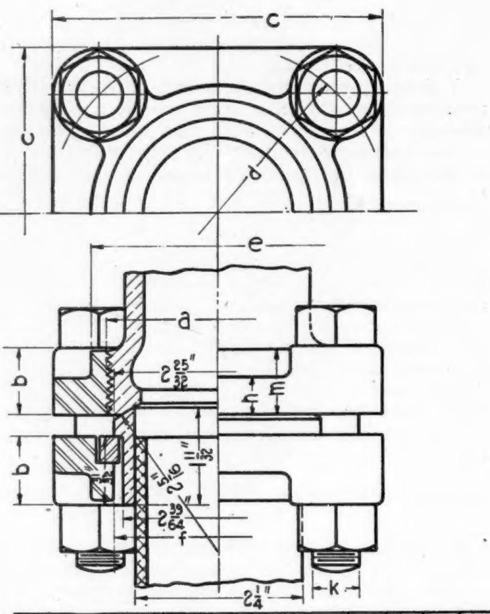
STYLE-W.



SIZE OF PIPE IRON	SIZE OF PIPE COPPER	a	THDS PER IN	b	c	d	e	f	k
1 1/2	1 3/4	2.362	10	25/32	3 15/16	3 11/16	3 15/16	2 1/8	5/8
2	1 3/4-2	2.826	10	25/32	4 3/8	4 1/4	4 3/8	2 25/64	5/8
2-2 1/4	2 1/4	3.031	10	29/32	4 1/2	4 3/8	4 1/2	2 39/64	5/8
2 1/2	2 3/4	3.472	8	15/16	5 1/16	5	5 1/16	3 ∔	5/8
3	3 1/4	3.960	10	1 1/32	5 11/16	5 3/4	5 11/16	3 35/64 Δ	3/4

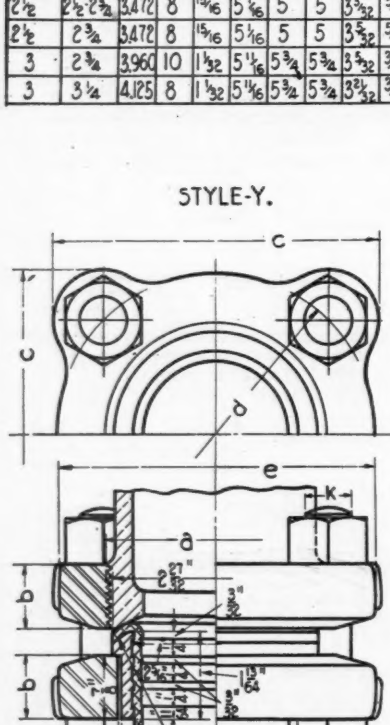
∔ 3 1/8 BORE FOR COPPER PIPE SLEEVE
Δ 3 5/8 BORE FOR COPPER PIPE SLEEVE

STYLE-X.

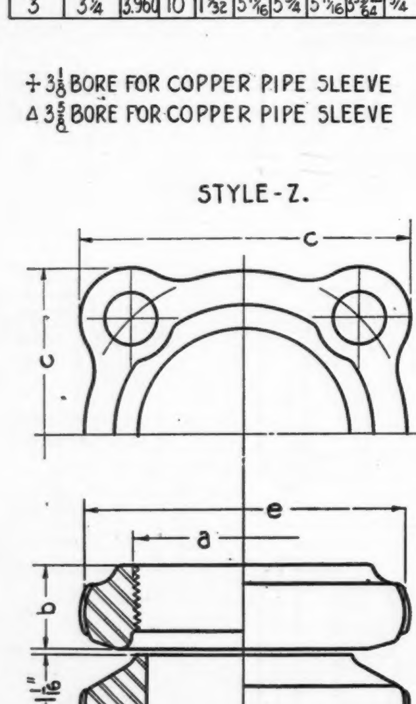


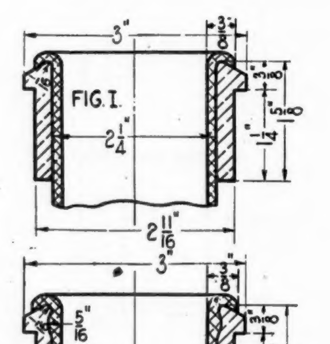
SIZE OF PIPE IRON	SIZE OF PIPE COPPER	a	THDS PER IN	b	c	d	e	f	k	m	n
1 1/2	1 3/4	2.392	10	13/16	3 5/8	3 5/8	2 7/8	2 1/4	1/2	3/4	3/8
2	1 3/4-2	2.812	10	13/16	4 1/4	4 1/4	3 1/4	2 5/8	5/8	3/4	3/8
2	2 1/4	3.	10	15/16	4 1/2	4 1/2	3 3/8	2 13/16	5/8	7/8	1/2
2	2 1/4	3.	8	15/16	4 1/2	4 1/2	3 3/8	2 13/16	5/8	7/8	1/2
2 1/2	2 1/2	3.50	10	15/16	4 7/8	5	3 15/16	3 1/4	5/8	7/8	1/2
2 1/2	2 1/2	3.50	8	15/16	4 7/8	5	3 15/16	3 1/4	5/8	7/8	1/2
3	-	4.125	10	15/16	5 5/8	5 7/8	4 9/16	3 7/8	3/4	7/8	1/2

STYLE-Y.



STYLE-Z.





SIZE OF PIPE IRON	SIZE OF PIPE COPPER	a	THDS PER IN.	b	c	d	e	f	k	STYLE
1 3/4	2	2.50	10	27/32	3 31/32	3 3/4	3 3/4	2 13/32	5/8	Y
2	2 1/4	3.02	10	7/8	4 15/32	4 3/8	4 3/8	2 21/32	5/8	Y
2 1/2	2 3/4	3.50	10	15/16	5 1/4	5 11/16	5 1/4	3 1/16	5/8	Y
2	2 1/4	3.02	10	1 1/8	4 15/32	4 3/8	4 3/8	2 21/32	5/8	Z

Fig. 2—Flanged Connections for Injector Piping

[The author showed the form and sizes of pipe connections coupling nuts, iron pipe unions and brazing rings as obtained from different makers.—Ed.]

ring collar was allowed to rest loosely on a collet and the copper pipe held in clamping jaws.

Nos. 8 to 11, inclusive, illustrate results of a series of

tests conducted on a 100,000-lb. Emery testing machine at the works of Wm. Sellers & Company, Inc. Tests were made on short lengths of 2¼-in. copper pipe with brazed connections at each end held against concave ball seats by coupling nuts. It was stated in connection with these tests that in each of these instances the copper pipe showed a marked elongation reducing in diameter from ⅛ to 3-16 in. before a failure of the joint. When it is considered that the pressure on a 2¼-in. copper pipe carrying 200 lb. steam pressure is approximately 600 lb., the above figures covering actual pressures at failure would indicate an ample factor of safety in a carefully brazed joint.

It is a fact generally accepted, however, that the method of brazing and the care with which a brazing operation is performed, play an all-important part in the results obtained as to service and reliability, the more so on account of the fact that it is not possible to determine by inspection just what percentage of strength the brazed connection may be expected to develop.

Mechanical Connection.—There has been developed during the past year a so-called "Mechanical Joint" for copper pipe. This connection consists merely of a beading ring or sleeve through which the copper pipe is extended and beaded over on the ball collar to form the ball joint seat. On Fig. 2 is shown the manner in which the copper pipe is applied to the beading ring, the application differing slightly as between the manufacturers. There has recently been put on the market a machine for mechanically rolling and beading the copper pipe into the ring. It is claimed that where a considerable volume of work is available for this machine that the operation is slightly cheaper than was the brazing operation.

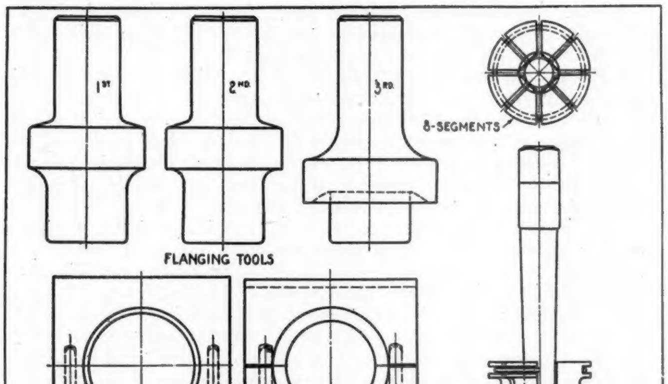


Fig. 3—Hand Tools for Beading and Expanding Copper Pipe

Where there is not sufficient work of this kind to justify the installation of a mechanical pipe-beading machine as described above, the work can be done with a set of hand tools similar to those shown in Fig. 3. The sequence of operations is as indicated on Tools 1, 2 and 3, after which the expanding tool is used, providing the application is being made to groove rings. As to this particular feature, there is some reason to question the real necessity for grooving the rings, and the writer has been given to understand that one of the large locomotive companies is making the application by merely rolling the pipe with a plain beading ring and beading the copper pipe over to form the ball joint seat.

Flanged Injector Connections.—Along with the mechanical copper-pipe connection mentioned in the preceding paragraph has been developed the use of flanged connections as illustrated in Fig. 2. A large number of new locomotives built during the past year have been equipped with these connections throughout the injector piping. The various styles in use and detail proportions are shown on this drawing. It will be noticed that while the general design of the flanges shown thereon is very similar, the threading varies slightly as to the diameter over the thread, Column *A*. This feature, of course, offers a real hindrance to complete interchangeability.

In the matter of service, as a general proposition, the flanged connection seems to be giving entire satisfaction. The Lake Shore & Michigan Southern has had for some time a number of locomotives equipped throughout the injector lines with these connections and has experienced no trouble whatever to date. There is every indication that this connection is going to eliminate entirely the many undesirable features necessarily connected with the use of coupling nuts, and that the mechanical pipe joint, while providing fully as good a joint as the brazed connection, has the added advantage that it can be thoroughly inspected.

DISCUSSION

S. L. Kneass (William Sellers & Co.): During the last year, I have had occasion to serve on a committee which had this very subject up for discussion. A careful investigation was made of the pitches and threads and various standards used, to find if it was not possible to reduce the number required for sizes running from 1¼ in. up to 3 in. to a minimum, and it was found that but slight modification was needed on minor dimensions to accomplish this purpose.

Some ten or fifteen years ago, I adopted a flat top thread, with a short root, measuring the theoretical diameter from the sides of the thread, placing a small cylinder on each side and calipering to the outside of the cylinder, then calculating the theoretical sharp diameter. It is from these dimensions that the correct diameter may be obtained. The shape of thread is a very efficient one. The flat top conforms closely to the Franklin Institute standard, and the small triangle allows for the collection of dirt or dust without spoiling the fit of the thread. The committee also took up the question of brazing rings, unions, and methods of connection of copper pipe to the rings. The first investigation was made to determine, the relative strength of the mechanical joint and the brazed joint. The results are included here in Mr. Foster's admirable paper.

I have just received a letter from the Interstate Commerce Commission's boiler inspector's office, in reply to a question as to the number of failures during the past year. The commission has under its care about 63,000 locomotives, and allowing for some four sets of connections per engines, it makes nearly 250,000 connections. The total number of failures last year was 15, and of those, I think, 6 or 7 were due to coupling nuts and the balance to the brazed connection, showing that even as done now, the brazed connection is not such an inefficient device, and it is one that can be fixed in almost any shop, whether it be small or large. In regard to the flange connection, although there are a large number of designs given, the variation largely consists in the form and in the shape of the flange, so that if a standard drawing be adopted, giving the pitch and diameters of the threads, and the pitch and size of bolt holes, the ground will be covered very thoroughly. The brazed connection and the mechanical ring are equally adaptable to the present standard of nuts as adopted by this committee, and the report of the committee, and the agreement which has been reached, now reduces the standards to such a small number as not to inconvenience any railroad desiring interchangeability. I would, however, like to add that I think the greatest offenders are the railroad and locomotive builders themselves; they are liable to not only manufacture their coupling nuts and brazing unions, when they desire to make replacements, with any kind of material that is handy, but are liable to adopt any thread or pitch that may happen to be convenient. My suggestion in this connection is that all connections, wherever possible, which have to be frequently removed, be designed so that they will correspond to the standard connections, not only as to pitch of thread and its diameter, but also as to diameter of the bolt joint, so that the heating system and the main pipe connections throughout the locomotive all correspond to the standard nuts and connections.

J. F. DeVoy (C. M. & St. P.): I have had to call the attention of our purchasing department to the fact, when purchasing injectors, sleeves or nuts, that the pressure under which they were to operate should be given the first and the greatest consideration of all. In the few failures that I have seen, the distorting of the nut, or the distorting of the body of the injector has had more to do with leaking than any other feature. No matter what the threads are, no matter what the design is, if the nut, the sleeve, or the injector is distorted in any way, it is absolutely impossible to get a tight joint. I have seen bodies and injectors cast in such a way that there was no metal in the side. My only reason in taking the floor at this time was to call attention strongly to the weight being equal to the pressure, and that the pressure should in all cases be specified.

President MacBain: While the statistics referred to by Mr. Kneass show that there have been fifteen failures known to the inspectors of the Interstate Commerce Commission, I am assuming that they indicate only the failures which caused injuries to employes. There are a great many more failures than fifteen occurring in a year, and we ought to make an improvement in the injector connections and all steam connections on the loco-

motive. As Mr. Foster in his paper has recommended, a committee should be appointed by the association to go into this subject and bring in a recommendation at the next convention.

J. F. DeVoy (C. M. & St. P.): I move that the executive committee be directed to assign this subject to a committee, with a view to preparing a standard and recommended practice. (The motion was carried.)

ELECTRIC MOTORS IN RAILWAY SHOPS

By B. F. Kuhn

Assistant Master Mechanic, L. S. & M. S., Collinwood, Ohio.

No hard and fast rule can be laid down as to just what system should be used in any particular shop until the local conditions at that particular point have been thoroughly studied and analyzed. Before adopting either the alternating-current or direct-current system the actual cycle of operation of each individual machine must be carefully considered before a selection is made.

Two hundred and twenty volts seems to be the ideal voltage for direct-current motor drive, and where the load is a mixed load of motors and lighting, three-wire direct-current generators can in many cases be used to advantage. The three-wire direct-current distribution also has its advantages for motor drive in that a wide range in speed can be secured and the motor will be operating very efficiently at all times.

The type of motor to use in any particular case must necessarily depend on the operation to be performed; thus on cranes and hoisting work the motors should in most cases be series wound, but there are some cases in hoisting and conveying work where it is necessary to use either a compound winding or an interpole motor, as it is possible under certain conditions for a straight series-wound motor to run away with a light load, and this would not be possible where the motor is provided with a shunt winding to prevent the speed of the motor reaching the danger point. This type of motor is also suitable for use on transfer-tables and turntables.

Then there are other operations which require a heavy starting torque from the motor and when in operation require that the motor drop off in speed as the load comes on; such a cycle of operation, for instance, as occurs on a punch or shear, or any other tool provided with a fly-wheel, and for this class of service a compound-wound motor should be used.

Then we have other drives which require comparatively small starting torque but require constant speed after being put in operation, such as driving line shaft or any similar operation, and for this class of drive a shunt-wound motor should be used.

In applying motors to machine tools you must again carefully consider the cycle of operation before selecting the winding for a motor, and many of the motors used on machine tools are combinations of the three different types of motors described above. On some machine tools a small amount of variation is sufficient and increases in speed from 10 to 15 per cent may be secured on the straight shunt motors, but where the range in speed would amount to 2 to 1, 3 to 1, or 4 to 1, motors for such operation should be of the shunt-wound interpole type. These motors commutate very successfully over the whole range in speed.

Wherever a cycle of operation is peaky as in the case of a planer, motors of the interpole type should be used. Just to point out what can be done in this matter of speed variation, I would state that there are in use today motors of 100-hp. capacity that have a range in speed from 100 r.p.m. to 1200 r.p.m. This variation in speed being secured without keeping in service any series resistance.

The direct-current system has certain advantages, particularly in its flexibility, for it is possible to secure a direct-current motor that will efficiently meet almost every conceivable cycle of operation.

The alternating-current motors are divided into three general divisions, namely, the short-circuit type induction motor, the slip-ring type induction motor and the synchronous motor. The short-circuit type induction motor requires from 3½ to 4½ times full-load current from the line while developing full-load torque at starting. The slip-ring type induction motor will draw 1½ times full-load current from the line while developing full-load torque at starting, and the synchronous motor will draw approximately three times full-load current from the line while developing three-tenths of full-load torque. The short-circuit type induction motor does not lend itself to variations in speed as does the shunt-wound direct-current motor and it is, therefore, suitable for constant speed operation only.

The resistance of the motor, however, may be varied so as to give almost the same characteristics as the compound-wound direct-current motor. This type of motor is especially adapted to punches, presses, etc., of moderate sizes, but there are cases where extremely large presses are used where it is desirable to use the slip-ring type induction motor rather than the short-circuit type.

The slip-ring type induction motor is used for hoisting, conveying, cranes, etc.

The beauty of the short-circuit type induction motor is that it has no moving contacts, the only rubbing parts being two bearings.

Some features that have been developed for different controls are the remote control which allows the operator to start or stop a motor which may be located some distance away. There is also the master-type controller in which the operator simply operates the master control and the controller itself is operated by electromagnets, thus relieving the operator of all the manual work. There has also been developed the push-button type controller, which simply requires that the operator to start a machine press a button and the machine will automatically come up to speed, the current being limited at all times by the controller so that there is no unnecessary jar or strain, as the tool starts from rest and comes up to its normal speed.

Woodworking Department.—In the woodworking department in many cases the motors can be direct connected to the machines, and in most cases high-speed motors can be used. If direct-current motors are used for this class of service they should be shunt-wound and entirely enclosed, and the starting box enclosed in metallic case lined with asbestos.

If the short-circuit type induction motor is used for this class of service they need not be dustproof, but the bearings should be dustproof and arrangements should be made to have the sawdust and shavings blown out of the motors at regular intervals and the motors should be provided in large sizes with oil-immersed compensators, and in small sizes where they are thrown directly across the line the starting switches should be enclosed in asbestos-lined metallic cases.

Where machines are equipped with their own individual blowers a great saving is effected as the blower is in use only during the time that the machine is in service.

General.—Motors have been made for almost every conceivable method of mounting and transmission. For gear driving 20 hp. is about the limit for two-bearing motors and there are some cases where even motors of 15 hp. should be provided with a third bearing in order to properly support the shaft, for as a general rule standard motor shafts are not heavy enough to stand the shocks met with in gear drives.

The losses in transmitting power electrically from engine to tool in the case of a shop equipped with individual motors for each tool seldom exceeds 30 per cent. But of course this is not the only advantage in the case of the individual motor for each tool. Take the case of a machine-shop containing a large number of tools at a time when you wish to operate only a few tools, the line shaft and friction losses are practically the same, as they are when all tools are in use. While in a shop with each tool provided with its own motor these friction losses are entirely eliminated.

There is also the advantage in having your generating station composed of several units so that if anything goes wrong with one unit only a portion of your shop may be shut down. Then, too, this is not always necessary, for generating stations will, as a rule, easily carry 25 per cent overload for a couple of hours and thus give sufficient time in some cases to make necessary repairs.

A few years ago the load factor of railroad machine-shops was about 19 per cent, and due to the introduction of high-speed tool steel and the motor for individual drive the load factor has been raised in some shops to approximately 37 per cent.

With shop equipped with tools for motor drive the whole shop layout can be rearranged from time to time to suit the various conditions which may arise in the method of handling the different work and also the installing of additional new tools, and it is also possible to take advantage of floor space which in the case of a shop with line shafting it would be impossible to utilize. A very distinct advantage that the shop equipped with motor-operated tools has over the shop operated with line shafts is that the belts and overhead work are done away with.

The paper was read by Mr. W. E. Dunham.

F. F. Gaines (C. of Ga.): There is very little argument about the flexibility and desirability of electricity around shops. There are, however, one or two little illustrations I should like to give you of how very flexible electricity is and what purposes it can be put to. We had occasion, about three years ago, to put in a high-pressure fire-protection system at our Savannah terminal, where we could maintain 100,000 gallons of water, and automatically fill the tank. This was taken care of by puting in electrically driven turbine pumps. We had a little trouble at first, with the bearings running hot, but the last two years we hardly know the plant is down there. We have the police department go in and look at it once in awhile, and about once a week have a man put a little oil on it. In another case, we had to put in a small pumping plant at an outlying point where we could get electricity, however. The big problem was the rise and fall of the river. There was a difference of thirty feet between high and low water. We had to place our motor up

out of the way, and get the pump down in the water. We put up a steel tower and placed a motor at the top, with a vertical shaft running down to the pump. It has been in operation some three years, and is taken care of by the force that looks after the cars and engines. It has given us practically no trouble whatever. It is automatically controlled by a switch which opens when the tank is full and nobody has to bother with it.

E. R. Webb (M. C.): Being connected with probably the very latest new shops that are being electrically equipped, I can certainly agree with all of the statements in the paper. We find that in going from the shaft drive to the individual motor drive, and from the group drive to the individual drive, that the advantage is very great.

W. H. Flynn (M. C.): We have recently built a new shop, at St. Thomas, which is electrically equipped throughout. We have had considerable experience with electricity in our shops at Jackson, but our first installation there was the group system. Since that time we have recognized the disadvantage of the group system, which entailed the use of a lot of belts, and our later purchases have been largely confined to individually driven machinery. In our St. Thomas shops we have gone to the individual group system to a slight extent, partly from the standpoint of economy, and partly also from an economical arrangement of the tools, but in large installations I am in favor of the individual system.

J. A. Pilcher (N. & W.): There is one feature I wish to speak of in connection with woodworking machinery, that is the largely increased output of the shop with the electric drive. We estimated we would have to buy a large number of new tools and build a larger shop, but we had a fire, which forced us to go into the electric drive quickly, and we find now that we did not need the new tools or even a new shop. The number of men in the planing mill was cut down to almost one-third, simply because the electric motors did not slow down when the load came on them. That is one of the most important points.

W. H. Flynn (M. C.): We have had an experience in building a new shop, and also trying to modernize a car shop by using electricity and centralizing the power into one power plant, and benefits are already apparent. We are going to operate one power plant at a less cost to supply a considerably greater amount of power than we previously operated two power plants.

F. F. Gaines, (C. of Ga.): It is astonishing how you can increase the output of your woodworking tools by the application of individual motor drive. We put a 50 h. p. motor on a four-sided planer, and I asked the man running the machine how he liked it, and he said: "We used to take a ¼-in. cut and now we take it all in one cut. If it is an inch we take it."

G. M. Crownover, (C. G. W.): I have charge of the shop of the Chicago & Great Western at Oelwine, but at the present time, the shop does not compare, in any way, with what it was when first equipped, for the reason we have found it a great advantage to equip the tools individually. It has led us to install our machines so we can put our shop rather on a department order, put the machines that belong in different departments together, so that the work can be assembled, and it is not dragged all over the shop. Our experience in the wood mill is the same as reported by others. We figure we are saving from 20 to 30 per cent. by getting from 20 to 30 per cent. more out of our shop, with individual motors. We have also installed two water pumps driven with electricity, that are pumping water a mile away from the roundhouse. The pumps are duplicate, working one at a time, with an automatic trip at the top of the tank, which will start the pump when the water goes down, and stop the pump when the tank gets filled. In that way we have been able to do away with the night and day men at the pumphouse, and we send a man to the place once in twenty-four hours to look after it.

J. F. DeVoy (C. M. & St. P.): I would like to ask Mr. Flynn is he has any information as to what he has saved by changing from group to individual drive, and if he has made up his mind as to how low he would go in size of a motor for individual machines?

W. H. Flynn (M. C.): We have been governed largely by the results which we have obtained, and while we have not any definite recommendations to make at this time, we are studying that now. We find that some small machines, where they are running constantly, can be grouped and run by a seven or ten h. p. motor, with very economical results, but we ran up against the question of power factor at Jackson. We were getting very poor results and we found it necessary to make some changes in grouping, abandoning some of the group drives in order to get more efficiency.

L. R. Pomeroy (U. S. Light & Heating Co.): In reading over the paper, it seems so general in character, that it is hardly discussable. I had hoped that there were some definite types to be presented, so that we could have definite information rather than glittering generalities. It is very hard to argue on general lines relative to either individual drive or group drives, unless you have specific cases. It seems to me that this paper would make a magnificent preface to a treatise on the subject. It has been quite a universal custom among the electrical experts not to go below five h. p. motors for individual drive, but that cannot be used as a definite law, because there are cases where the operation of carriages to existing machines, does not require more than two or three h. p. The questions of utility and economy have to be weighed against the first cost.

E. W. Pratt (C. & N. W.): We are up against what experience you have had with regard to the total capacity of your motors, in wood-working mills, as compared with your generators. I think Mr. Pilcher gave us some information on that, without the figures. If we have a total of 200 h.p. in motors in our mill, what generator will we require on an average?

John A. Pilcher (N. & W.): The question of the operation in the mill would depend upon how extensive the mill is, and how many classes of machines are being operated. We find that very often different classes of motors are advantageous; we decided on about a fifty horsepower motor on a Forsythe plane. We found it advantageous to put a 75 h.p. motor on it. When we came to put a motor on it, where the old engine aggregated 250 horsepower, the motors aggregate 1200 or 1500 horsepower. It depends entirely on how you group your machines, and which group is in service. We always group machines so that any particular piece that will go through will go through quickly before it stops. The arrangement of the particular mill I have in mind is such that the same group of men will operate the different groups of machines at different times, so the question is a very hard one to answer definitely.

L. R. Pomeroy: Mr. President, to show you how that question could not be answered offhand, I will give an illustration. Ordinarily, if the motors average 15 h. p., each generator would be about 30 per cent. of the aggregate of the horsepower in the motors.

J. F. DeVoy: A number of years ago, our woodworking mill at Milwaukee burned out. At that time we were operating with a Corliss engine of about 600 horse power. We rebuilt the mill and equipped nearly all of the machines with individual driven motors. The total power consumption of the motor-direvn mill as against the belt-driven arrangement was 63 per cent. That is, we had saved 63 per cent. in power by the long shafts. I found it gave very good results. A large blower ought to be direct connected to its own motor. I think you can save possibly 40 per cent. Of course, the blower has a good deal to do with that question.

As to the relative capacity of the motors and the generator, the generator capacity should be 75 per cent. of the total capacity of the motors. The standard of the Milwaukee road is to employ a 30 horse power motor as its standard unit for driving small machines. We have gone as low as 15 horse power motors for group driven machines. We have gone as high as 80 horse power for individual driven machines, so that if you employ a roller bearing, and the shaft is not over 30 ft. long, it is safe to say that you are well within the limits of economy if you employ a 15 horse power motor. I am not sure that I would go much lower than that. The cost of repairs to the individual motors will be in direct proportion with the number of motors that you use. The loss of time due to group driven machines, I do not believe, is as great as it would be for individually driven machines.

In a record that I kept, covering one year in all of our three largest shops, we only had a failure of one 30 h. p. motor. That is the only time that I have ever seen any shutdowns, and it simply required replacing the motor which was being repaired. I am in favor of group driving the small machines, provided you can get them within the limits of line-shaft capacity which I have spoken of, say 30 or 40 ft., but I do not think I would go beyond that.

E. W. Pratt (C. & N. W.): In our roundhouses, we put a motor even on a hacksaw, and a small high-speed drill, so it may be used any time, day or night, without the necessity of starting up a large motor, either group driven or otherwise. I should like to ask if there is any disadvantage in the way of dust, and also whether there is any difficulty in taking care of the shaving after you have delivered the shavings and borings from the individual machines to the main conduit.

J. F. DeVoy (C. M. & St. P.): We did have some trouble with our lines to the engineroom. As a matter of fact, I had to readjust the trunk lines, say, two-thirds of the distance away from the motor. It took us three months before we finally got the blower lines adjusted.

L. R. Pomeroy: On one job where I made a test of a double blower, the power being consumed by the blower was 80 h. p. I went down in the shop and closed off the gates at the machines that were not being operated and found that it only

required 40 h. p.; the blower, of course, is run at the capacity of its openings. Also avoid carrying a horizontal load. Go vertically or at an angle of about 45 degrees and you can carry the shavings with much more celerity than you can carry them horizontally.

George W. Rink, (C. R. R. of N. J.): We have a motor installation in connection with our planing mill, consisting of two 25 h. p. blowers, driving over all the sawdust. With a 35 h. p. blower we drive the shavings, after the sawdust has been separated from the other refuse, a distance of 600 feet, over to the powerhouse. We have had this plant in operation over two years, and have met with great success. We consider we are working that plant very economically, in view of the fact that all the drop pipes to the machines are fitted with gates, and these gates of closed when the machine is not in operation. We are very partial to the use of the interpole motor. Care must be taken in selecting your motor. We get one with a proper sized frame. The trouble with a great many manufacturers is that they have too small a frame in connection with their rated sizes of motors. In connection with roundhouses, I believe it would be preferable to use a group drive, especially where you have but few machines. Arrange your machinery into two groups, so that on Sundays or other holidays you can simply use one group and allow the other to remain idle. When our plant was started in 1902, all of our machinery in the machine shop was operated by group drives, and we have since eliminated the overhead shafting and applied individual drives to all the machines in the machine shop.

S. G. Thompson (P. & R.): The study of group drive is a very interesting one, and is pretty nearly entirely different for every case you take up. The load factor is the biggest proposition to consider. If you get down to a small group of machinery and then figure just how much those machines are running together, you can figure out fairly closely what your load will be, and that will give you approximately, without getting too much over the mark, what your motor ought to be. Possibly it is an advantage to take a small bunch of machines and put them on one motor, but a great deal will depend, particularly in mill work, where the work comes in spasmodically, on the amount of work they do. Then there is another question, power factor, which is a very interesting proposition, when it comes to the alternating current work. In one of our shops we had four or five, alternating current motors running the main shafting through the shops. We tested these motors, and found they were running light. They were all coupled together running the main shaft. We cut that shafting in two places, as I remember, and cut one motor out, altogether. That, of course, increased the power factor very much, and afforded us considerable advantage, and it drew our power factor up five or ten per cent. In other words, in alternating current work, in driving long shafting, a great saving can be made if you run the motor as near to the capacity as you can possibly get it.

E. Jansen (I. C.): I think at a plant where the power plant furnishes power to the machine shop, the blacksmith shop, and other plants, that the power demand in the mill should be about 50 per cent. of the total rated capacity of the motor. Today the Underwriters, in all the large cities, require that a wire be put in of twice the capacity of the motor, which means the conduit twice the size, wire twice the size, circuit-breaker, and so forth. Therefore a motor of sufficient size should be used, but not one that is too large, on account of the cost of the work. If you use the other type of current motor, you do not require the circuit-breaker.

SPECIAL TRAINS FOR CHICAGO AND NEW YORK

As announced in earlier issues of the *Daily*, special efforts are being made this year to secure enough people to warrant the running of special trains from Atlantic City to Chicago and New York immediately after the close of the Master Mechanics' convention. Fifty-five persons have already made reservations on the special train for Chicago, which will leave at 2 o'clock Wednesday afternoon, getting to Chicago at 5 o'clock the following evening. A large number have also signified their intention of taking the 3.30 P. M. trains to New York over the Pennsylvania and the Reading-Central of New Jersey. Representatives of both of these roads may be found at the Information Bureau and will be glad to make reservations and look after the securing of tickets. Please call at once and make your wants known in order that sufficient equipment and trains may be arranged to insure a comfortable and quick trip home.

A SERIOUS AUTOMOBILE ACCIDENT

Frederick G. Bird, general foreman boiler maker of the American Locomotive Company, and his son George were both killed on Saturday, when an automobile in which they were riding was struck by a Lake Shore train at Ripley, New York.

M. M. MEMBERSHIP

The following figures give the comparative number of members in the Master Mechanics' Association at the present time, as compared to the secretary's report for last year:

	1913	1914
Active	1,009	979
Associate	21	19
Honorary	44	48
Total	1,074	1,046

TRAVELING BAG FOR HAROLD BROWN

As a token of recognition of faithful services rendered, the members of the enrollment committee presented their chairman, Harold A. Brown, of the "Pocket List of Railroad Officials," New York city, with a handsome leather traveling bag. Mr. C. W. Beaver, of Yale & Towne Manufacturing Company, made the presentation speech.

ASSOCIATE AND HONORARY MEMBERS

At the meeting of the convention yesterday, Professor A. J. Wood, of the Pennsylvania State College, was elected an associate member.

R. H. Briggs, who has been a member of the Association since 1879 and was president in 1889 and 1890, was elected an honorary member.

William Garstang, who has been a member of the association since 1887 and was president of it in 1894 and 1895, was also elected an honorary member.

REGISTRATION FIGURES IN BOOK 4

Following are the comparative registration figures in enrollment list No. 4 for the years 1911, 1912, 1913 and 1914. There is little change in the relative relation of these figures as compared with those which have been previously published in the Daily for the first three books.

	1911	1912	1913	1914
Members M. C B. and M. M	712	445	575	631
Special Guests	757	449	495	451
Ladies, Railroad	699	329	426	352
Ladies, Supply	399	218	282	272
Supply Men	1684	1446	1574	1403
Total	4251	2887	3352	3109

MR. SCHURCH HONORED

The members of the entertainment committee quietly gathered in the office of the *Daily Railway Age Gazette* Monday afternoon and formally summoned to their presence the chairman, John F. Schurch. They told him of their willing obedience under his leadership during the conventions and extended to him wishes of all good fortune through life. At the same time Mr. Schurch was handed a handsome set of full dress cuff buttons and studs, of pearls set in mother-of-pearl, in platinum mountings.

New Station for English Channel Traffic.—The South Eastern & Chatham is said to be making excellent progress on the construction of its new commodious marine station at Dover to provide the necessary accommodation for the increasing cross-channel traffic.

IN APPRECIATION OF BEN HEGEMAN, JR.

In presenting B. A. Hegeman, Jr., the retiring president of the Railway Supply Manufacturers' Association, with a past president's badge, C. B. Yardley, Jr., made the following address:

"As you are of course aware, it has been the custom in our Association to indicate in a tangible manner the hearty feeling of appreciation which we all entertain for the valuable services rendered by our retiring president, and the speaker feels himself especially privileged in having been selected to convey to Mr. Hegeman our gratitude to him at this time when, to our sincere regret, he is leaving our official family.

"A few days ago, while in conversation with Mr. Hegeman, I asked him why he had retained the Junior to his name, and he replied that it was because his father was a good man. Now, personally, I believe it is because nature has decreed that the spirit of youth in him shall be perpetuated.

"Mr. Hegeman, during your term of office we have failed to discover that you have committed any errors of judgment, or in any manner whatever neglected a single duty,—and it is a great relief for us to say this for the reason that it takes a great deal of courage to tell such a big man as you his faults.

"Your honesty and frankness, under all conditions, has been an absolute safeguard against the wiles of gold brick promulgators and green goods disseminators.

"Your physical proportions and commanding presence have incurred our profound respect, and your careful attention to the advanced styles of raiment has caused us to look upon you as an exponent of the tailor's art, and also as a shining example to those neglectful people who allow their clothes to grow so old that the moths won't eat them.

"Your optimism is beautiful and as refreshing as the morning dew—really acting as a tonic to those who imagine that fate is against them if they don't find a fifty dollar pearl in a twenty-five cent oyster stew, and also to those who linger at first base so long that they never make a home run.

"Your sobriety has been remarked, and there has been noted your careful avoidance of the society of those who can drink a half gallon of 'mountain dew' and then swallow the cork for fear they will spill some of it.

"You are a splendid 'mixer'—wearing no rubbber soles to erase your footmarks; you are equally entertaining and at home in any society, be it composed of men with whiskers flying and a general air of innocence, a bunch of accidents rambling around trying to find a place to happen, or a gathering of staid men who are noted for their business ability. These, and many other wonderful qualities, we have observed in you, which it has been our pleasure to applaud, but above all have we admired your own business acumen, combined with the beauty of your character, of goodness, simplicity, modesty and gentleness, and in appreciation, we, your associates, upon your retirement from that office which you have so ably filled, beg to tender and ask your acceptance of this past president's badge. We trust you will not only value it for its intrinsic worth but also for the sentiment which we desire it to convey as indicating an appreciation of your splendid service, the good will and friendship of this body of men, who recognize you as a man amongst men, and who desire your friendship for all time.

"Mr. Hegeman, in behalf of the Railway Supply Manufacturers' Association, permit me most humbly to tender you this emblem of our appreciation and regard."

ADDITIONAL MASTER MECHANICS' REGISTRATION

Alexander, Walter, D. M. M., C. M. & St. P., Shelburne.
Allison, W. L., W. S. M., Franklin Ry. Supply Co., Marlborough-Blenheim.
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Baker, Geo. H., Ry. Educational Assn., Marlborough-Blenheim.
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Bickford, S. A., M. M., N. Y. C. & H. R., Arlington.
Blake, R. P., M. M., N. P.
Booth, J. K., Gen. Foreman, B. & L. E., Traymore.
Boyden, J. A., M. M., Erie, Chalfonte.
Brangs, P. H., Heine Safety Boiler Co., Traymore.
Brennan, E. J., M. M., B. R. & P., Chalfonte.
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Davey, Thos. S., M. M., N. Y. S. & W., Jackson.
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George, W. A., Supt. Shops, A. T. & S. Fe, Traymore.
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Gordon, H. D., Jenkins Bros.
Grimshaw, F. C., A. E. M. P., Penna., Shelburne.
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Haig, M. H., M. E., A. T. & S. F., Traymore.
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Hayes, W. C., S. L. O., Erie, Chalfonte.
Hildreth, F. F., M. E., Vandalia, Dennis.
Hill, W. H., M. M., Cornwall, De Ville.
Hinkens, E. H., S. S., B. & O., Traymore.
Hoke, H. A., A. E. M. E. D., Penna., Haddon Hall.
Hunter, H. S., M. M., Phila. & Reading, Bouvier.
Irwin, I. B., G. F., P. S. & N., Lexington.
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Kirkpatrick, James, M. M., B. & O., Alamac.
Larry, W. L., M. M., Mass. Public Service Comm., Chalfonte.
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Manchester, H. C., S. M. P., D., L. & W., Traymore.
Maness, W. C., M. C. B., National Rys. of Mexico, Traymore.

Mannion, T. D., M. M., Atlantic City.
March, F. E., A. M. M., Penna., Shelburne.
Markey, Jas., M. M., Grand Trunk, Traymore.
Marshall, Thos., G. M. M., C. St. P. M. & O., Rudolph.
Maxfield, H H., M. M., Penna., Chalfonte.
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Mechling, J. E., M. M., Vandalia, Haddon Hall.
Miller, S. W., Prop., Rochester Welding Wks., Haddon Hall.
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Muchnic, Chas M., Amer. Loco. Co., Marlborough-Blenheim.
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Malthaner, W., M. M., Dela. & Hudson Co., Alamac.
Maness, W. C., M. C. B., National Rys. of Mexico, Traymore.
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Cavey, J. S., Eng., B. & O., Dunlop.
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Daubert, S. E., Genl. Night Foreman, Phila. & Reading.
Dolo, H. L., Chief M. & P. Clerk, Retired, Penna., Alstine.
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Kelley, Simon, Foreman, Phila. & Reading.
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LITTLE INTERVIEWS

GEORGE POST ON THE BUSINESS SITUATION

George Post, president of the Railway Business Association, when we asked him for a message which would be of special interest to convention attendants at this time, said:

"I am glad to avail myself of the proffered space in your columns to give expression to my great pleasure in again being in attendance upon the annual meeting of those whose activities are focused on the mechanical departments of railways.

"To the railway men here assembled I proffer my felicitations upon the gratifying fact that in the pending application by the railways to the Interstate Commerce Commission for permission to increase freight rates, no charge of inefficiency has been lodged against the railways as a reason for denial of the increase. Four years ago, the most widely published and the most vehemently urged reason given for refusing the then desired increase was that if the railways were *efficiently operated* a million dollars a day could be saved, and, therefore, no more money would be needed by the railroads. That statement took deep lodgment in the public mind. It is tremendously important, therefore, to record and to call specific attention to the fact that, in the recent hearings before the Interstate Commerce Commission, no charge of inefficiency was made or hinted at, while, on the contrary, the distinguished lawyer who four years ago made the welkin ring wtih his outcry against railway inefficiency, was this year profuse in the bestowal of compliments upon railway officials for their notable accomplishments in the line of economical administration.

"To one so deeply interested in the good repute of the railways as I, it is most pleasing to note that those who now oppose the increase of rates do so with no reflection upon the manner of the operation of the roads, but, rather, press to the front the fact that because the roads are now *so efficiently run* through the economies effected, their need of greater earnings is questionable. Isn't that a great stride? Admirable efficiency is now conceded!"

"Of course the alleged inefficiencies, formerly made, were greatly exaggerated; but no matter, whatever they were, they are now no longer the subjects of condemnation. This is so because such men as are here in Atlantic City in attendance upon these mechanical conventions, and their associates in the other departments of railway service, have by study, genius and brilliant achievement eliminated them from consideration.

"I take off my hat to the brainy, resolute, conscientious railway men who have done these things. It is truly a wonderful transformation in the attitude of those whose apparently permanent vocation it is to criticise the railroads, that they are now bending their energies to show *not that the railroads are*

earning too much, but that through some other than existing traffic regulations which they hope to develop it may be found *how they may earn more which they concededly need at the expense of a few rather than from all.*

"Although there are still other measures pending in Congress that cause anxiety in railway circles for fear that they may become law without proper and conservative consideration, I think that it is the truth, and a happy truth, that there is now a clearer conception of railway necessities and a higher appreciation of the splendid service rendered by our railways than ever before.

"To the railway supply manufacturers, who have for many months been suffering sharply from the famine in orders, I desire to renew my oft-repeated tribute to their remarkable commercial courage and philosophic good humor. The day cannot be far off when again the din of activity will break the prevalent silence in our factories. Railway necessities are piling up; crops that will strain the vehicular capacity and other facilities of our railways are ripening to the harvest. A public, eager and insistent upon adequate transportation facilities, and administrators of the law who must be conversant with the fact that the crux of our present industrial stagnation is the depression in railway and railway supply circles, will, I am confident, some cut the leash that ties us by such action as will revive prosperity."

A FEW WORDS FROM SECRETARY M'GINTY

Secretary McGinty dropped into the office Saturday morning to pass the time of day and we asked him two or three little questions, the answers to which are of special interest at this time.

Asked how the Commission would develop and build up its staff if the Stevens bill should become a law, he said: "If we can have the hearty co-operation of the railroad officers, and there is no question in our minds but that we will, the problem should not be a very serious one. We will need to have a number of experts—men of such experience and training as to fit them thoroughly for the work which it will be necessary for them to handle. These men are now employed by the railroads, and we can only locate and secure their services with the aid and co-operation of the railways. Without this help we will have to do the best we can, and will hardly be able to secure the men who are best fitted for the work.

"I was greatly interested in the suggestion which was made yesterday to the effect that just as the railroads have special experts, who look after fuel economy, lubrication, air brakes, and a hundred and one important items, so it will be necessary to have experts who will look after the safety appliances and see that they are properly applied and maintained. If this is done, and from what I have heard since I have come to the convention, I think it will shortly be the general practice, the roads will be relieved of much inconvenience and unnecessary expense."

When told of the story which is going the rounds on the Pier, to the effect that the Interstate Commerce Commission had a number of secret service men at the convention studying the conditions pertaining to and surrounding the meetings, he was not only very much surprised, but, to be perfectly frank, seemed to feel more or less hurt.

"I am very sorry that this impression has gone forth and wish you would use your influence to correct it. Of course, it is untrue. We have fourteen of our men here, most of them from the safety appliances division. Some of them go home tonight, but a number of boiler inspection men will replace them. We are not here to look for trouble or find fault. Our intention is rather to have our boys get better acquainted with the railway officers, so that a better understanding and feeling may be developed. We are here to help the railroads. We should feel very badly, indeed, if the impression which you mention is at all widespread."

Conventionalities

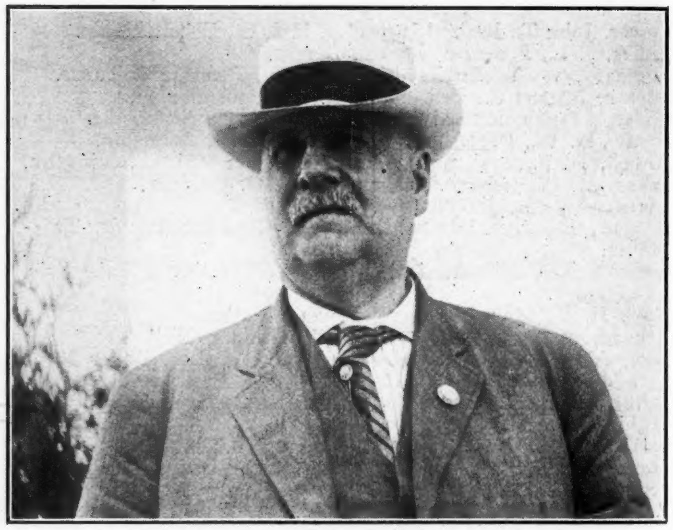
If the B. & O. man who lost a photograph that has been cut down to fit his watch case will call on W. E. Weatherly, in booth 516, he will learn where he can find his property.

Judge James H. Reed, president of the Besseman & Lake Erie, is at the Marlborough-Blenheim Hotel. He did not come to attend the conventions, but was a welcome visitor on the pier yesterday.

H. C. Bradley, staff expert of the Galena-Signal Oil Company, with headquarters at Buenos Aires, Brazil, in charge of the business of the company for the Buenos Aires & Pacific Railway is attending the conventions for the first time.

A. W. Horsey, formerly mechanical engineer of the Canadian Pacific, has the record of being the first one of the convention visitors to fly over the city in the hydroplane, which has been doing such spectacular work during the past few days.

Mr. Schlafge, in speaking to one of his friends about the performance of the Triplex locomotive, remarked that it



F. R. McFeatters, Superintendent, Union Railroad

would pull 7,500 tons. He neglected to say, however, how many drawheads it would pull—at least this is what his friend told us.

David Van Alstyne, assistant to the president of the New York, New Haven & Hartford, arrived on Sunday evening and will spend the next few days meeting his old friends and looking into a number of problems which he is specially interested in at this time.

The friends of A. E. Shultz, of Ryan, Galloway & Company are extending their heartfelt sympathy to him, as it is their understanding that his side pal, Ed Ryan, is to talk at the North Western luncheon and that Mr. Ryan is trying out his "speech" on Shultz. Hence the sympathy.

P. T. Warner, of the Baldwin Locomotive Works, spent Monday in Atlantic City. Mr. Warner reports that his wide-spreading Panama hat, which he brought back with him from his trip to the Panama Canal last year, has spent some time in the back shop and is now completely remodelled.

Miss Elizabeth Smith, daughter of B. A. Smith, of the W. H. Coe Manufacturing Company, has been constantly obliged to deny that her youthful looking father is her brother. Miss Smith is known as the patron saint of the enrollment committee, and when she passes the booth business is suspended.

If any one at the convention has any doubt as to the benefits to be derived from a "dip in the deep" we would suggest that they run out and have a chat with our friend Hines of the Railway Utility Company. L. P. has been in every day, rain or shine and is now the fellow who put the "Pep" in pepper.

Prof. Louis E. Endsley and Family, Professor of Railway Mechanical Engineering, University of Pittsburgh

George R. Carr, of the Dearborn Chemical Company, was late in arriving at the convention owing to Mrs. Carr having suffered a sudden attack of appendicitis. Mrs. Carr had planned to make this her first convention, and, needless to say, is greatly disappointed. Her condition was much improved before George left home.

A. R. Ayers, General Mechanical Engineer, New York Central Lines West

Henry Gardner, until recently supervisor of apprentices on the New York Central Lines East and now assistant shop superintendent of the Baltimore & Ohio at Mt. Clare, has slipped over to attend the conventions for a couple of days. He reports that he is getting along nicely on the new job. Mrs. Gardner is with him.

James Ogilvie, mechanical expert of the Board of Railway Commissioners at Ottawa, is again attending the conventions this year. Mr. Ogilvie, however, has found that the change in climate in coming from Ottawa to Atlantic City has not agreed with him. He is suffering from a severe cold and found it necessary to leave for home on Sunday afternoon.

Atlantic City is evidently not fast enough for W. S. McGowan, of the American Brake Shoe & Foundry Company. Desiring to travel at a faster clip, he made a flight with Aviator E. H. Jaquith in his Curtiss hydroplane, but was forced to signal for distress, the "juice" running out. The last we saw of him McGowan was headed up the boardwalk to secure a fresh supply of engine thirst quencher (?).

Dave Redding, assistant superintendent of motive power of the Pittsburgh & Lake Erie, reports that the new Railroad Y. M. C. C. building at Hazleton was dedicated with a grand flourish in spite of the high temperature which prevailed in the Pittsburgh district last week. When Dave started for the convention his boss, L. H. Turner, was busy milking the cows on his farm at Hazleton.

Chas. L. Acker, Master Mechanic, Toledo Terminal

W. E. Woodhouse, superintendent of motive power of the Canadian Pacific lines east of Fort William, Ont., has but recently left the West to assume his present position. Mr. Woodhouse has been on the Western lines of that road for some years as master mechanic of the Western Division, superintendent of the Winnipeg shops and assistant superintendent of motive power. He held the latter position until his recent promotion and transfer to Montreal.

Louis D. Freeman, who has just been appointed shop superintendent of the Seaboard Air Line at Portsmouth, Va., and who the readers of the Mechanical Edition of the *Railway Age Gazette* will recall as a frequent contributor, is attending the convention this year. Mr. Freeman went with the Seaboard Air Line about a year ago in a subordinate capacity, and his rapid promotion is undoubtedly well deserved.

Norman Collyer, chief clerk to the president of the Southern Pacific, and Thomas G. Gray, apprentice instructor of the same road at Sacramento, Cal., visited the Pier Thursday afternoon and evening between the sessions of the National Association of Corporation Schools. They are making a study of apprenticeship methods as conducted on other roads and industrial concerns. At the close of the meeting at Philadelphia they expect to go on to New York.

Wilbur D. Arter, supervisor of apprentices of the New York Central, is attending his third convention. Mr. Arter, up to a few months ago, was connected with the mechanical engineer's office and succeeded to the duties of supervisor of apprentices when Henry Gardner left the New York Central to go to the Baltimore & Ohio as assistant superintendent of the Mount Clare shops. He also reports to the superintendent of motive power on special matters and is particularly interested in fuel economy.

Frank Hyndman, superintendent of motive power of the Wheeling & Lake Erie, reports that the little road is as busy as could reasonably be expected, and that the Brewster shops are running a large part of the time in order to keep up with the running repairs. This year he is accompanied by his mechanical engineer, R. C. Pattison; his master mechanic, J. F. Hill; his secretary, R. M. Frank, and his machine foreman, F. Reigler. The general foreman of the car department, C. Hagen, attended the M. C. B. convention, but has returned to Brewster.

H. T. Nowell, assistant shop superintendent at the Billerica shops of the Boston & Maine, arrived Monday. Mr. Jennings, the shop superintendent, finds it impossible to attend the meeting this year. The new shops were opened up about the middle of February, and at the present time

T. W. Demarest, Superintendent of Motive Power, Pennsylvania Lines West

are operating at full output. Last month heavy repairs were made to 40 locomotives and light repairs to seven. Of the 40 heavy repairs, 37 were heavy general repairs, while three of the locomotives required new fireboxes. The shops are fully meeting the expectations of the designers.

Robert Blake, master mechanic of the Northern Pacific at Fargo, N. D., is attending his first convention and has Mrs. Blake with him. They had a pleasant time in Pittsburgh on Saturday visiting with W. P. Richardson, mechanical engineer of the Pittsburgh & Lake Erie, and W. L. Kinsell, of the Westinghouse Machine Company, both of whom were graduates of the University of Minnesota, attending that university at about the same time that Bob was finishing his course. Mr. and Mrs. Blake spent Sunday in Philadelphia, and directly after the convention will leave for a short trip to New York, getting back home about the end of the month.

The wonderful advance in the railway supply field is no more clearly shown forth than by a comparison of the exhibits of today with those at Saratoga ten years ago. This was demonstrated by Walter Leach in talking with some of his friends yesterday. It is just ten years since Walter first exhibited the Hunt-Spiller gun iron at Saratoga. He had a 3 ft. by 5 ft. space on the hotel veranda, with one or two castings and a few twisted specimens. As a matter of fact, Walter was about all there was to the company, combining in one person the functions of salesman, foundry manager, purchasing agent and treasurer. The foundry output was nine tons a day; now, under normal conditions, it is 65 tons, with a capacity of nearly 100 tons. No wonder Walter is proud of his organization and the work it is doing, and judging from the appearance of the Hunt-Spiller sextette, Mrs. Leach takes an equal interest in the organization.

Left to Right: Wm. Schlafge, General Mechanical Supt., Erie; J. W. Young, Kerite Wire & Cable Co., a Former Erie Man; W. A. Cotton, Chief Clerk to Mr. Schlafge; John McMullen, Mechanical Supt. of the Erie

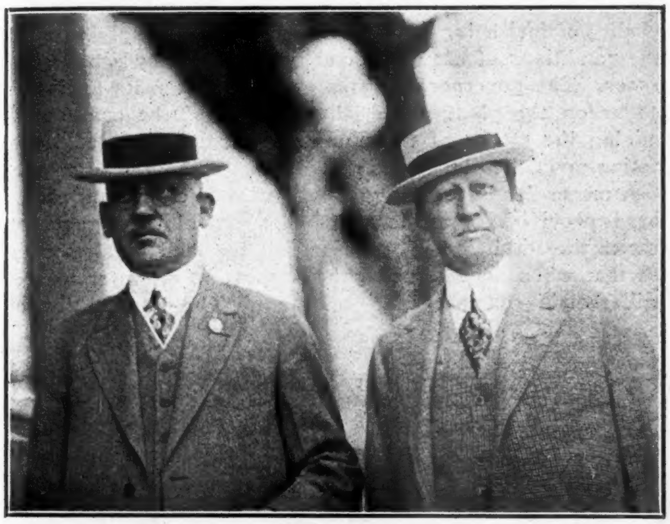
A. W. Wheatly, vice-president and general manager of the Canadian Locomotive Works at Kingston, Ont., arrived on Sunday. He is very enthusiastic over the new erecting shop which was opened for business about a month ago. The steel work is now being erected for a machine shop which will be specially devoted to the handling of frame, cylinder and wheel work and will be about 80 ft. x 200 ft. in size. This is a part of the general plan of rebuilding

R. Q. Prendergast and Wife; Mechanical Superintendent of the Bangor & Aroostook

and rearranging the plant in order to increase its capacity and improve the efficiency for handling the work. Other representatives of this company who are attending the conventions are William Casey, efficiency engineer, and Gustave Cavin, assistant mechanical engineer. These men

are possibly better known to convention attendants when their names are used in connection with the Casey-Cavin reverse gear which they have developed.

Among those who are attending the convention for the first time are Mr. and Mrs. Geo. N. Steinmetz, of New York. Mr. Steinmetz is the contractor who built for the government the great seawall and jetties at Galveston, Texas, and the Roosevelt dam in Arizona. In speaking of this work, Mr. Steinmetz said the transportation problem at Galveston



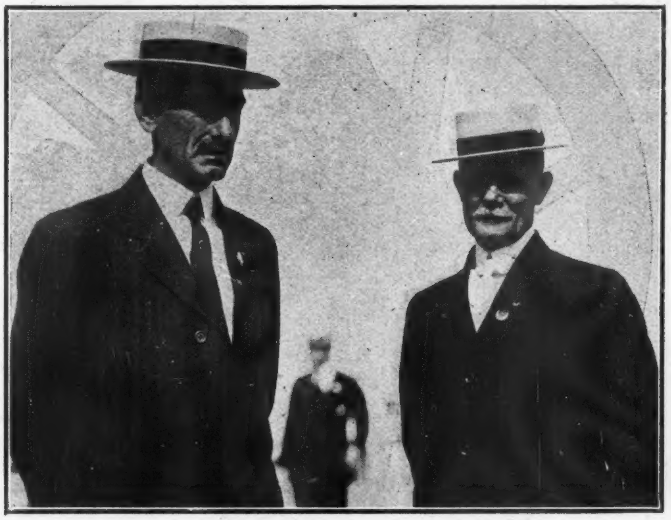
Left to Right—J. J. Waters, Superintendent Motive Power, Pere Marquette; J. V. Bell, American Steel Foundries

required constant service of 700 cars in bringing the stone from the quarries, which were 300 miles away. As the result of the construction of the seawall and jetties, Galveston was raised to second in rank of ports handling foreign tonnage. The harbor is absolutely safe and a truly great port. The transportation problem at the Roosevelt dam was much smaller. Although sixty miles from the railroad, it was

Left to Right—W. W. Daley, Master Mechanic, New York, Ontario & Western; A. Kipp, General Car Inspector, New York, Ontario & Western; W. H. Kinney, Master Mechanic, New York, Ontario & Western

found possible to make cement at the dam site. A cement mill was built and a saving of a half-million dollars was effected on the cost of theis material. This dam is considered one of the greatest pieces of modern masonry. It has 350 000 cubic yards of cement work and supplies 350,000 acres of land with water, with a reserve capacity of three to four years' demands. Mr. Steinmetz is secretary and treasurer of the Prince-Groff Company, maker of a well-known water gauge. Charles H. Spotts, who has attended these conventions for many years, is also with the same company and is introducing Mrs. and Mr. Steinmetz. Mrs. Steinmetz is greatly pleased with the social side of the convention.

Mr. and Mrs. Eugene du Pont motored over from Wilmington yesterday and are stopping at the Marlborough-Blenheim. Mr. du Pont is vice president of the Standard Stoker Company. Frank L. Connable, president of the company, also arrived last evening. With the arrival of Mr. Connable comes a good golf story which we learn has already made a deep impression upon two members of his official staff. It seems that Mr. Connable had arranged for Jack Carey and Dave Williams to spend a week-end in Wilmington, which included a Sunday golf game. On this particular day the local papers were featuring a story, inspired by Sinclair, the I. W. W. leader, to the effect that the Blue Laws of Delaware were to be enforced. The seriousness of the situation bcomes apparent as the threesome approached the fifth hole, for the game was on. Two austere gentlemen, both starring, addressed the group and in the name of the law "pinched" the trio. An argument followed; then persuasion, induce-



Left to Right—Wm. F. Eberle, General Foreman, Pennsylvania, and B. W. Renner, Assistant General Foreman, Pennsylvania

ment and indignation, but finally persuasive inducement of a familiar kind won, providing they agree to appear in court at two o'clock the next day. Back again in the Club House, Williams got a tip and he immediately shifted the load to Carey. About noon time Monday, Carey broached the subject of who was going to appear in court and learned from Connable that it was in the attorney's hands and to "forget it." That ordinarily would have ended the incident. However, a week later Carey received a short note from Connable substantially as follows: "Dear Jack and Dave—About that little trouble on the links Sunday I learn that the Judge has trebled our fines for not appearing as agreed. Won't you each enclose your personal check for $22.50 to settle this confounded scandal?" Of course, Williams renigged, but Carey—well he got an opportunity a few days later while at luncheon at Mr. Connable's summer home, to tell his old friends the whole story of how it happened, embellishing portions of the narrative so as to reflect upon Connable. But someone of the diners let mirth get the best of them and Carey tumbled. It seems that Connable had collected the deposit from the Sheriffs as well as the Judge's fine.

LOW GRADE FUEL OIL ENGINE

A low grade fuel oil engine has recently been developed by the Chicago Pneumatic Tool Company and a 12 in. by 12 in. 25 h. p. engine of this type is in operation at the booth of this company, driving the compressor which is supplying compressed air for the exhibits. It is claimed to operate successfully on any petroleum distillate, including residuum, fuel oil and crude oil.

It is valveless and simple in operation. The firing is automatic, thus eliminating timing gears and all electrical apparatus from the construction. Fuel is introduced directly into the cylinder through a combination ball check valve and nozzle without the use of a carburetor.

The cylinder is of the two-cycle low compression type. The water jacket is cast integral with the cylinder but covers only that portion in which the combustion takes place. This construction simplifies the cylinder casting and facilitates the equalization of temperature at all points. The cylinder head is a single piece casting, thoroughly water jacketed. Studs and nuts hold the head to the cylinder and permit internal inspection at any time without destroying the gasket.

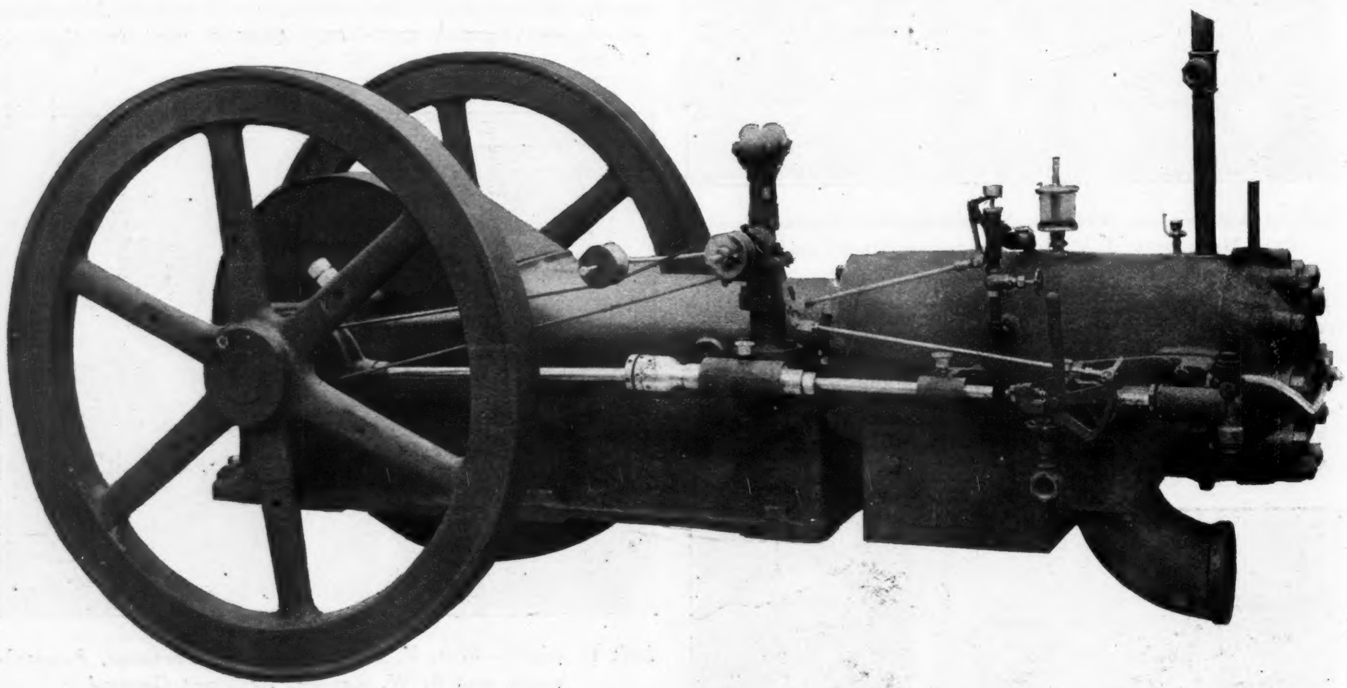
The trunk type of piston is employed and four self-adjusting eccentric spring rings are provided. These are made wider than the admission and exhaust ports to prevent catching or breaking. The deflector is of a form that has been adopted after exhaustive experimental research. It is designed to insure effective scavenging of the cylinder at each stroke.

A notable feature in the design of this engine is the employment of a piston rod and crosshead, together with a cylinder closed at the crank case end. This construction has a number of advantages. It eliminates cylinder wear, resulting from the angular thrust of the connecting rod, and very materially reduces the volume of the compression chamber, thus making possible a higher admission pressure, and more thorough scavenging of the cylinder. A splash system of lubrication can be employed in the crank case without the possibility of lubricating oil working back into the cylinder and disturbing the regulation of the engine.

The method of igniting the fuel charge is positive and simple, requiring no sensitive adjustments. A thin circular concave plate is rigidly secured to the face of the piston and after the engine is started, fuel injected against this hot plate is instantly vaporized and ignited. By this means air only is compressed in the cylinder. The fuel is injected directly into the cylinder through the centre of the cylinder heads thus preventing loss of fuel through leaks in the compression chamber and during the compression stroke. In starting the engine the fuel is ignited by means of an externally heated tube connected to the combustion chamber.

The injection of fuel into the cylinder is effected by means of a pump operated by an eccentric on the crank shaft. The stroke of the pump plunger may be adjusted to suit the quality of fuel being used. Variation of fuel supply to meet the conditions of changing load is controlled by a ball governor. The governor operates a cam which rests against a collar on the plunger rod, the position of the cam determining the stroke of the plunger. A hand operated lever, acting upon the plunger, is provided for stopping the engine.

A means for introducing water into the combustion chamber is provided. A needle valve under control of the governor varies the admission of water to suit the load requirements, so that when once adjusted the proportion of water to fuel will remain constant under all loads. The introduction of water into the combustion chamber is claimed to materially reduce carbonization, and to effect a better distribution of pressure throughout the working stroke of the piston.



Oil Engine for Burning Low-Grade Distillates

The governor, oil pump, and water control valve are all shown in the illustration. Lubrication of the operating parts is effected by the splash system in a closed crank case. The cylinder is lubricated by a sight feed oiler, clearly shown in the illustration.

CAR REPLACER.—The Kelley Railway Appliance Company is exhibiting a type of car replacer which involves a number of new features. The replacer used inside the rail differs somewhat from that used on the outside. Each replacer is arranged to hook over the ball of the rail and fits in place against the base of the rail, that no lateral movement is possible. A lip projecting downward from the rear end of the casting is designed to hook against the side of a tie to prevent longitudinal movement. The guiding grooves are designed to allow a pair of wheels which are on the track to be run over the replacer without danger of derailment.

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DAILY EDITION

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WE GUARANTEE, that of this issue more than 9,000 copies were printed; that of those more than 9,000 copies 7,535 were mailed to regular paid subscribers to the Railway Age Gazette, weekly edition, and Railway Age Gazette, Mechanical Edition; 224 were provided for counter and news companies' sales; 241 were mailed to advertisers and correspondents; and 1,000 were provided for distribution at Atlantic City.

The Standardizing of Tinware

There are, as M. K. Barnum said in discussing the report of the committee on the standardizing of tinware, too many matters which should be standardized, but concerning which there are varying ideas among mechanical men, who persist in the retaining of their own ideas on their particular roads. The tinware in general use in the mechanical department should not be difficult to standardize, and is there any good reason for their being in everyday use almost as many designs of oil cans as there are railways? No standard was ever adopted without a compromise in ideas, and tinware is used and replaced in sufficient quantities to make probable the introduction of standard practice in a comparatively short time after its adoption.

Big Returns for a Small Investment

Various guess estimates have been made from time to time as to the total cost of holding these conventions, and these estimates have run from half a million dollars up. But as to the cost of the Master Car Builders' Association we have a good index in the financial report of this year. There are at present about 2,700,000 freight cars in this country. The net cost of the association was $24,540 last year, making a net cost of about 0.9 cent per freight car per year, with nothing for passenger cars. If these cars are given an average value of $800 each, then the rate of taxation for the support of the Master Car Builders' Association would be .001125 per cent. of freight car value. When the value of the work of the association to the railroads and the country is considered, it is certainly what would be called, in business parlance, a paying proposition.

Locomotive Boiler Construction

The fact that no report was rendered by the committee on boiler construction and design, perhaps brought more encouragement than a report could have done. The statement from the chair that investigations were under way that promised more definite and valuable information than yet existed, is certainly a strong one, but not one apt to come from such a source unless well founded on probabilities. Then Mr. Bell's statement, as to the probably interesting developments of the use of powdered fuel and the water tube boiler, adds two old features that have long been before the mechanical world, but which have not yet been satisfactorily worked out. Hence expectations have been raised to a high pitch, and the forthcoming report will be looked for with all of the interest that it will probably deserve.

Progress of Locomotive Superheaters

How different was the discussion on superheaters from anything that had preceded it. The attachment is now regarded as a fixture. No one is asking as to its efficiency or the advisability of using it. Both are settled propositions, and the only points now are the general details of its operation and maintenance. Lubrication still attracts attention, though causing no trouble of a serious nature. It is a matter, too, of materials, the fitting and the methods of repairs, all of which are being worked out by the railroads as individuals. This means a variation of practice, which also indicates the desirability and value of comparing notes. It is certainly a strong indication of the readiness of railroad men to adopt a new device of merit, that, in the course of so few years, a device of such a radical nature as the superheater could have been received, applied and adopted. There are so many elements influencing the superheater that it will be some time, probably, before they will all be settled to general satisfaction and approval. But the attitude assumed Tuesday morning regarding it shows how completely it has been accepted.

A Thorough Headlight Discussion

Again the Taylor (Joe, not Fred) efficiency curve had a kink put in it by the presentation and discussion of the first paper on the morning's program. Headlights had a discussion that should have warmed the cockles of the hearts of the committeemen who were responsible for that masterly production. For two solid hours the floor was continuously occupied, and occupied with the heaping up of proofs and experiences of the accuracy of the conclusions drawn. It was a case of shoulder hitting from the start, with no attempt to parry or mitigate statements. There could be no doubt in the minds of any that Mr. Crawford, the chairman of the committee, was terribly in earnest, nor could there be any doubt as to his position on the subject. The report is sweeping in its statements, and the thoroughness with which the work of investigation has been accomplished leaves little to be done. More work can be done in a further analysis of the results, and a corroboration of the testimony by further investigations, but it would seem that this is about all that there remains to be done, insofar as the determination of headlight intensities are concerned. The continuation of the committee for the purpose of settling upon a method of headlight examination is a necessary move, and will tend to make practice more uniform throughout the country. It will also show legislators that it is well to have some technical information before passing compulsory headlight laws, and it is to be hoped that an example in this respect may have an influence in other matters also. The report is to appear in a separate volume and will add one more to the many valuable reports that have been published by the Master Mechanics' Association.

Returns Come Fast

Information comes to the editor's desk from thousands of sources far removed from each other, and is then assimilated and such of it as is worth while is sent out to the readers through the columns of the paper. It is hard to trace definite results from the impressions which these messages make upon the reader. Sometimes the editor may find, years after he has written and published an article, that it has had a strong influence upon the work or development of one of the readers, or in inspiring or developing some move of progress. Usually, however, he never knows just what results have been produced, and really never expects to know. Probably the quickest result of improvement which has been inspired by our efforts is indicated by the communication from Mr. Lane on another page. We have been very heartily commended by members of the Association for calling attention to the limitations and defects in the present Convention Hall, and it is gratifying to know that Mr. Lane has placed himself on record in saying that additions and improvements would be made during the coming year, if the conventions decide to again visit Atlantic City next year.

GOVERNMENT REGULATION OF HEADLIGHTS

THE comprehensive report on the headlight question presented yesterday marks another very important development in connection with this matter. A few years ago state legislatures and railway commissions in various parts of the country began, at the instigation of the railway brotherhoods, to pass laws and issue orders requiring the use of high power headlights. It was contended by railway officials that such action was not justified. When the matter came before the Railroad Commission of Indiana it employed Prof. C. H. Benjamin, of Purdue University, to make a series of tests. Prof. Benjamin reported that the tests showed that high power headlights were undesirable on the lines having block signals. The Commission nevertheless issued an order requiring them to be used. The railways appealed to the courts, and made additional tests. Their investigators agreed with Prof. Benjamin in his conclusions. The Wisconsin Railroad Commission also made an investigation the results of which were unfavorable to the requirement of the use of high power headlights. The results of the tests made by the Master Mechanics' committee, and the conclusions reached by it harmonizes with those set forth in the earlier reports referred to.

In view of the results of these various investigations, the headlight laws that have been passed in various states stand forth as fine examples of the kind of railway regulation that ought not to be adopted. Before laws regulating railway operation are passed it ought to be ascertained that a large preponderance of expert opinion is to the effect that the thing to be required will tend to promote economy or safety. In most of the states no attempt whatever was made to ascertain what expert opinion on the subject of headlights was, and no effort was made by the lawmakers or railway commissioners to learn anything about the matter for themselves. It was acertained that the railway brotherhoods wanted high power headlights and that they controlled, or claimed to control, a large number of votes. The political aspects of the question having been ascertained by the lawmakers and commissions, they were content to ignore entirely the question whether a requirement that high power headlights be used regardless of conditions would or not be in the interest of safe transportation.

It should be clear to the regulating authorities that either the reports of the various investigations that have been made are entirely untrustworthy or that all the state headlight laws should be repealed or nullified. They can hardly be repealed without the co-operation of the railway brotherhoods, but this it probably would be hard or impossible to secure. It is probable that the best and fairest course to adopt would be that proposed in the Stevens bill now before Congress. This provides that the Interstate Commerce Commission shall determine, by "practical tests," the minimum conform illumination to be used. The expense of the tests required to be made by it must not exceed $10,000, and no part of the expense of such tests shall be paid in whole or in part by any railroad company, any organization of employees, or any manufacturer of headlights, excepting that the locomotives and tracks used in making the tests may be placed at the disposal of the Commission by any railroad company without charge. The Bureau of Standards of the Department of Commerce is directed by the bill to co-operate with the Commission in making laboratory tests.

If this provision were passed, the Commission no doubt would not only make tests, but also give representatives of the labor unions, of the headlight manufacturers, of the railways and of all concerns and persons full opportunity to be heard; and it is only fair that this should be done. The Commission could then take such action as it might decide to be fair, giving all proper consideration to differences in conditions. There can be little question, in view of the recent decision of the Supreme Court in the Shreveport case, that any order the Commission might make, would be paramount, and would nullify every state regulation that conflicted with it. This would be an eminently desirable result for the existing regulations are inconsistent, conflicting and unjust.

THE DISCUSSION ON SUPERHEATERS

THE discussion of the committee report on superheater locomotives brought out a number of interesting points. Some roads seem to be having practically no trouble from worn piston rings, while others still have considerable difficulty. The Lake Shore & Michigan Southern has got away from the trouble to a large extent by giving careful attention to the fit of the piston in the cylinder and the fitting of the rings. On one division of the Michigan Central, piston rings give approximately three times the service that they do on another division. The Lackawanna obtains an average of 9000 miles to a set of rings in high speed passenger service, but the practice is followed of examining the rings every 30 days; this practice seems to be enforced on several other roads. Emphasis was laid on the necessity of giving attention to details if satisfactory results are to be obtained from superheaters. The superheater cannot be expected to run indefinitely without receiving careful attention, and still perform its intended function.

O. M. Foster, of the Lake Shore, stated that his road has managed, to a large extent, to get its enginemen away from the idea of carrying the water high in superheater locomotives. This is a practice that has become general on many roads, and its elimination would seem to rest, to a considerable extent, in the hands of road foremen. The superheater has been in use long enough now for mechanical men to have learned pretty well for what purpose it is intended, but there are many enginemen, and some officers, who do not seem to have grasped the idea that it is not intended as a steam dryer. When water is carried so high in the boiler that some of it is carried over to the superheater, part of the heating surface of the latter is given over to turning the water into steam. The heating surface of the superheater, when compared with that of the boiler, is so small that if a comparatively small amount of water is carried over it will use up so much of the heat that should be employed in superheating, that as a superheater the device may prove almost, if not entirely, needless.

Another condition that will result when water is carried over is the covering of the inside of the superheater elements with scale. This scale forms a hard coating of insulation on these tubes, through which it is difficult for heat to penetrate, and again the amount of superheat desired is not obtained. Enginemen should be carefully instructed regarding the effects of high water and every means taken to prevent their following the practice.

TODAY'S PROGRAM

MASTER MECHANICS' CONVENTION

WEDNESDAY, JUNE 17

Discussion of Reports on:	
Smoke Prevention	9.30 A. M. to 10.00 A. M.
Revision of Standard Efficiency Tests of Locomotives	10.00 A. M. to 10.15 A. M.
Revision of Air Brake and Train Signal Instructions	10.15 A. M. to 10.30 A. M.
Train Resistance and Tonnage Rating	10.30 A. M. to 11.15 A. M.
Fuel Economy	11.15 A. M. to 12.00 M.
Individual Paper on:	
Tests of Schmidt Superheater and Brick Arch, by Mr. W. H. Coddington	12.00 M. to 12.30 P. M.
Resolutions, Correspondence, etc.	12.30 P. M. to 12.45 P. M.
Unfinished Business	12.45 P. M. to 1.00 P. M.
Election of Officers, Closing Exercises	1.00 P. M. to 1.30 P. M.

LOST

Badge No. 4366. Please return to office of the Enrollment Committee.

FOUND

A walking stick; owner please call and identify at the Secretary's office.

A gold cuff button, marked with letter M, was found on the Country Club golf links. Owner should get in touch with the Caddy Master.

A key, a camera and a lady's parasol have been found. Call at office of Secretary Conway to claim them.

A TEA ON THE PIER

The chairman of the Entertainment Committee, John F. Schurch, introduced a most pleasing little novelty during the orchestral band concert on the Pier Tuesday afternoon. While listening to a select program by the band, the 300 ladies present were served with tea and light refreshments. Mr. Schurch gave the affair his personal attention, and the novelty and its completeness in detail was thoroughly enjoyed.

SECOND GOLF PRIZE

The play-off for second prize in Sunday's golf tournament took place Monday afternoon at the Country Club. The contestants in the tie score were Horace Baker, general manager of the Queen & Crescent, and George T. Johnson, of the Buckeye Steel Castings Company.

Mr. Baker proved to be the winner and was awarded the silver cup. The score:

	Gross	Haandicap	Net
Baker	101	25	76
Johnson	106	24	82

FINE GOLF SCORES

The many members of the three associations who played golf in the tournament of Sunday and who negotiated the 18 holes of the Country Club of Atlantic City and found the course fairly difficult will be interested in reading the scores of four supply men who greatly enjoyed a closely contested foursome at the Country Club Monday afternoon. The players were "Ned" Sawyer, of the Illinois Steel Company, and "Bob" Gwalthney, of the T. H. Symington Company, playing against "Hoover" Bankard, of the Cambria Steel Company, and "Joe" Bole, of the Patterson-Sargent Company. It will be seen by the score, as printed below, that remarkable golf was played.

	Out	In	Total
Sawyer	30	38	68
Bankard	39	33	72
Bale	36	37	73
Gwalthney	40	37	77

It remained for a supply man from the West to visit the conventions and incidentally lower the amateur record for one of the most noted golf courses of the East. Mr. Sawyer's score of yesterday broke the amateur record of 69 made by Morris Risley. It may be noted for the purposes of comparison that the professional record for the course is 66, made by J. J. McDermott, professional champion of the United States.

REGISTRATION FIGURES

The following figures, furnished through the courtesy of chairman Brown of the Enrollment Committee, give the comparative data of the attendance for the past four years, as shown by List No. 5. The figures speak for themselves. The attendance of members of the railway associations is practically the same as for the bumper year 1911. There is, however, a considerable falling off in the number of supply representatives.

REGISTRATION FIGURES IN BOOK 5.

	1911	1912	1913	1914
Members M. C B. and M. M	732	644	678	730
Special Guests	759	584	680	554
Ladies, Railroad	709	437	505	433
Ladies, Supply	399	223	308	287
Supplymen	1695	1516	1666	1484
Total	4294	3404	3837	3488

A BETTER CONVENTION HALL PROMISED

P. E. Lane, representing the Million Dollar Pier, called at the office of the *Daily* yesterday morning and said that he had read the editorial entitled "A Better Convention Hall Needed," which had appeared in that morning's issue, and would authorize us to make the following statement:

"You are hereby authorized to state that should the M. M. and M. C. B. Associations come here next June, the Convention Hall will have a transept added to speakers' end of hall, making additional room at the rostrum end 38 ft. x 40 ft., making the width 78 ft. This will allow chairs to be nearer to speaker and the speakers' platform will be double the length it now is. Also Crex carpet will be laid outside of the Temple for the full width of walk-way in front and alongside."

R. S. M. A. COMMITTEE CHAIRMEN FOR 1914-15

The executive committee of the Railway Supply Manufacturers' Association for the year 1914-15 organized yesterday, with President J. Will Johnson presiding. The new members elected were all present, including F. E. Beall, C. E. Postlethwaite, Phillip J. Mitchell and George H. Porter. The president appointed the following committees:

Exhibit: Joseph H. Kuhns, chairman; J. C. Whitridge, C. E. Postlethwaite.

Finance: F. M. Nellis, chairman; J. C. Currie, C. F. Elliott.

Badge: C. B. Yardley, Jr., chairman; Oscar F. Ostby, George H. Porter.

Hotel: Oscar F. Ostby, chairman; S. M. Dolan, Phillip J. Mitchell.

By-Laws: C. F. Elliott, chairman; F. E. Beall, George H. Porter.

Entertainment: George R. Carr, chairman.

Enrollment: Harold A. Brown, chairman.

Transportation: George T. Cook, chairman.

J. D. Conway was re-elected secretary-treasurer for the ensuing year.

M. M. INFORMAL DANCE

The principal social event of the M. M. convention was the largely attended informal dance Tuesday evening on the pier. There was possibly a larger number of convention people present than on Thursday night of last week.

The special feature of the occasion was the dancing of Miss Wylma Wynn and Ernest Evans, whose very interesting numbers drew hearty applause. The dances given were the hesitation waltz, tango, maxixe, cubist gavotte, variation two-step and the new "half-and-half."

The arrangements for the evening were in the hands of the entertainment committee, which was represented by Messrs. Krepps, Hegeman, Crowe, McMasters, Ryder, Bankard and Lowman.

LITTLE INTERVIEWS

We couldn't understand exactly why it should be necessary to stand a butcher's block on its edge, and as we paused before the exhibit of the West Coast Lumber Manufacturers' Association, R. G. Hutchins started to tell us all about it. Said he:

"The large manufacturing interests, through the West Coast Lumber Manufacturers' Association, are showing the different lumber cuts.

"Douglas fir is the timber that grows on the west slope of the Cascade Mountains from California to Alaska. There is today one thousand five hundred billion feet of available saw log timber. This standing timber, worth from a dollar to five dollars a thousand, makes one of the greatest assets in the United States.

"Douglas fir is the lightest, strongest and highest grade of lumber produced today. The average size log produces a large percentage of clears. The heart of the Douglas fir saw log is sound and produces car sills, framing timbers, ties and building dimension lumber."

That he is a typical booster may be seen from the following statement:

"In building new cars or repairing old ones, we believe Douglas fir lumber to be the lightest, strongest and highest grade obtainable, and lasts the longest."

After studying the cartoon in Monday morning's *Daily* and looking over our cheerful comments on the 1915 boost for San Francisco, G. W. Heintzelman, general superintendent of motive power of the Southern Pacific, dropped in to emphasize the invitation which had been so cleverly presented in the cartoon from D. P. Kellogg. Asked why he felt that it would be wise for us to take the conventions to San Francisco next year, he said:

"You fellows have had the meetings at Atlantic City for a number of years, and while it makes an ideal place for a convention, we really feel that the members of the associations would find relief and a very considerable amount of enjoyment and profit by holding one of the meetings in the Far West. Moreover, it will enable a number of your members to attend the conventions who are ordinarily unable to do so because of the long distances which it is necessary for them to travel.

"Conditions are ideal for holding the meeting at San Francisco. The Supply Manufacturers' Association can provide an exhibit, or if it is thought wise, the transportation department exhibit at the fair may take its place. Undoubtedly good facilities will be furnished for holding your meetings on the fair grounds, or, if you prefer, there are a number of suitable places which you can make your headquarters and where you can hold your meetings in San Francisco."

Mr. Heintzelman received the following telegram from W. R. Scott, vice-president and general manager of the Southern Pacific, which was read at the meeting yesterday:

"Wish you would use your influence and every argument possible to secure for San Francisco convention of Railway Supply Men, Master Mechanics and Master Car Builders in 1915. You can promise cool weather all the time, besides attractions of exposition which will never be duplicated elsewhere."

Mr. Heintzelman remarked with considerable enthusiasm that "we Westerners will make things mighty comfortable for you, and you can depend upon it there will be no limit to our hospitality."

The San Francisco boomers are quite enthusiastic over the rapid rate at which the fair buildings are being completed, and Mr. Heintzelman estimated that the work was now about 20 per cent. ahead of the schedule.

Asked if facilities would be available for printing the *Daily*, Mr. Heintzelman emphatically stated that it would be impossible to hold the convention without the *Daily*, and that there was no doubt but what facilities would be provided, if they were not already at hand.

AN ASSOCIATION SCHOLARSHIP STUDENT REPORTS

H. A. Houston, motive power inspector, Chicago, Rock Island & Pacific, one of the boys who has gone through Purdue University on the Ryerson Scholarship, made a few remarks in appreciation of the help received by this scholarship, as follows:

"I appreciate this opportunity of having a chance to say just a word to express to you my grateful appreciation for your generosity in bestowing your scholarship upon me. As probably most of you know, this Association, in co-operation with a prominent railway supply firm, has established at Purdue University three scholarships, the first in 1903, the second in 1907 and the third in 1911. These scholarships carried with them a cash value of $2,000, which was given to the recipient in monthly installments during his four years at the University. The recipient was required to undergo a competitive examination and to have had at least 18 months previous railway shop experience and there were other incidentals which were requisite in the competition.

"I was given to understand that there were no obligation attached to these scholarships except the moral responsibility of the recipient to engage as diligently as possible in his studies and the work mapped out for him, in order that the donor would feel that he had been amply repaid. Your generosity in placing the second scholarship of Purdue University in 1907 was my means of gaining a technical education. My transfer, so to speak, from the 'Frisco shops at Springfield, Mo., under G. A. Hancock, general superintendent of motive power, to Purdue University, was what I consider one of the greatest events of my life. It meant to me everything. I tried to do all I could by diligently pursuing the work outlined for me, entering into the University work both on the outside of the classroom, and on the inside.

"At the end of my course there I was awarded membership in both of the scholastic societies of that institution. I merely tell you this so that you may know I attended to business while at school at your expense; I left no stone unturned to reflect honor upon the scholarship which you had and do maintain at that institution. For two years subsequent to my graduation I worked under Dr. W. F. N. Goss, an associate member of this Association and Director of the Engineering Experimental Station at the University of Illinois, and for the past year I have been connected with the Rock Island lines in Chicago under W. J. Tollerton, general mechanical superintendent.

"I believe, briefly, that this just about covers my history since I have been connected with this Association in that manner, and I have felt it quite a privilege to have been connected with you as I have been, and I want you to know from my heart I appreciate everything that has been done and I hope to merit the advantages which you have given me. For your assistance in the past and for your attention now, I thank you."

Master Mechanics' Association Proceedings

Reports on Locomotive Headlights; Standardization of Tinware; Superheater Locomotives; Use of Heat Treated Steel

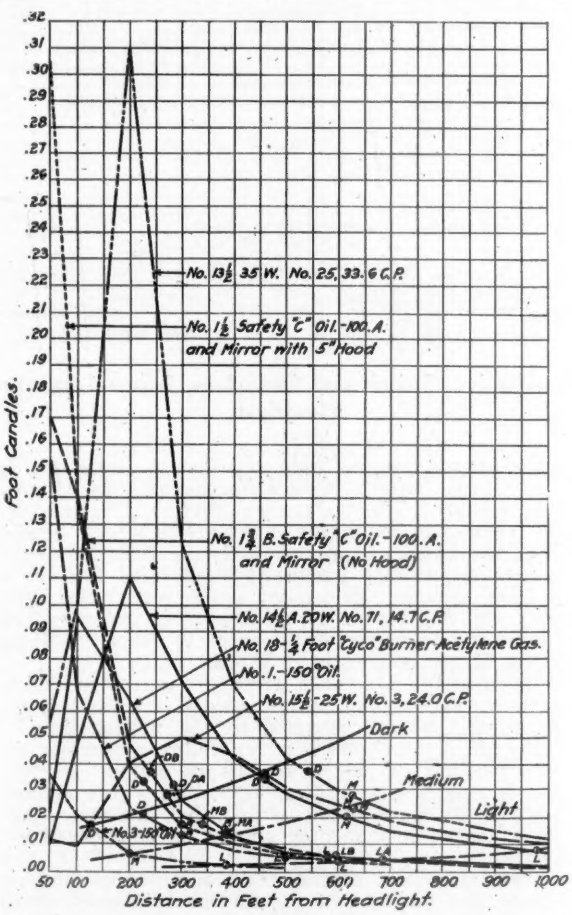
President MacBain called the meeting to order at 9.40 a.m. Tuesday.

LOCOMOTIVE HEADLIGHTS

The printed report of the Committee consists of 330 pages of text and plates. An abstract of the report follows:

There being no special instructions, the committee decided to make a complete investigation of the subject in hand, taking into consideration all viewpoints. In order to thoroughly cover the work, the majority of the type of headlights now on the market were procured and additional headlights were assembled, in order to completely cover the range of light intensity from the minimum oil headlight to the maximum electric arc headlight. The investigation was then carried on to determine the desirable and objectionable features of headlights of different intensities, irrespective of the character and the source of light, arrangement and design of reflector, etc.

In rating the headlights it was decided to assume as the reference plane the horizontal plane 3 ft. above the rail ahead of the locomotive, and to consider the intensity of the rays striking this plane at various points. All laboratory readings were taken normal to the ray in a vertical plane 25 ft. ahead of the focal center and perpendicular to the axis of the beam. Readings were taken at angles to correspond to stations in the reference plane 50, 100, 200, 300, 400, 500, 600, 700, 800, 900 and 1000 ft. ahead of the focal center measured along the axis of the beam. Three points were taken for each station—one corresponding to the center of the track and one corresponding to 20 ft. each side of the center, the three points being in the same straight line at right angles to the axis of the beam.



Visibility Curves—Headlights Rated in Foot-candles

CONCLUSIONS AND RECOMMENDATIONS.

After going over the results of these tests in detail and after thorough discussion, the committee recommends as follows:

1. In order that a headlight shall be of such intensity as not to cause misreading of signals, obscuring of hand signals, fusees, red lanterns and classification lamps by opposing headlights, and be of such intensity as not to temporarily blind the engineman looking into same, a headlight must have an apparent beam candle-power, not greater than 3000, referred to the center of the reference plane, from 500 to 1000 ft. ahead of the locomotive.

2. In order that the engineman shall have sufficient illumination ahead of the engine to allow him to readily perform his duties while operating in and out of passenger terminals and industrial sidings, while switching in yards, and to readily locate whistle posts, yard limit and crossing signs and such other landmarks en route, a headlight, due to depreciation or to variations in the intensity of the source, must not at any time during service have apparent beam candle-power less than the following; the readings to be made in a vertical plane 25 ft. ahead of the focal center and referred to points at the various stations in the reference plane.

READINGS AT CENTER OF REFERENCE PLANE

Reading point ahead of focal center.	Apparent beam candle power.
500 ft.	Not less than 450 c. p.
600 ft.	Not less than 490 c. p.
700 ft.	Not less than 500 c. p.
800 ft.	Not less than 500 c. p.
900 ft.	Not less than 500 c. p.
1000 ft.	Not less than 500 c. p.

AVERAGE SIDE READINGS (AVERAGE OF READINGS TAKEN AT EACH STATION 20 FT. EACH SIDE OF THE CENTER).

Reading points ahead of focal center.	Apparent beam candle power.
50 ft.	Not less than 30 c. p.
100 ft.	Not less than 110 c. p.
200 ft.	Not less than 225 c. p.
300 ft.	Not less than 315 c. p.
400 ft.	Not less than 350 c. p.

The above readings are to be considered independent of the location of the headlight, the source and intensity of light, the design of the reflector, etc.

To design a headlight to meet the above requirements, the height of the headlight above the rail must be decided upon; then with a given kind of light, the design of reflector, the relative arrangement of reflector and source of light, and the intensity must be such that the readings will fall below the designated maximum with sufficient margin above the minimum requirements, that they will not at any time, during the depreciation of the source of light, reflector, etc., fall below the minimum requirements.

A tabulation of the center and side readings of the maximum and minimum requirements is given as follows:

MAXIMUM 3000 CANDLE POWER—HEADLIGHT 9'-7" LOCATION

Center	Sides		Sides
1150 c. p.	50 ft.	180 c. p. plus 45 equals	225 c. p.
2100 c. p.	100 ft.	680 c. p. " 170 "	850 c. p.
2650 c. p.	200 ft.	1600 c. p. " 400 "	2000 c. p.
2850 c. p.	300 ft.		2450 c. p.
2950 c. p.	400 ft.		2700 c. p.
3000 c. p.	500 ft.		2800 c. p.
3000 c. p.	600 ft.		2800 c. p.
3000 c. p.	700 ft.		2800 c. p.
3000 c. p.	800 ft.		2800 c. p.
3000 c. p.	900 ft.		2800 c. p.
3000 c. p.	1000 ft.		2800 c. p.

MINIMUM 500 CANDLE POWER—HEADLIGHT 9'-7" LOCATION

Center	Station	Sides
95 c. p.	50 ft.	30 c. p.
195 c. p.	100 ft.	110 c. p.
295 c. p.	200 ft.	225 c. p.
365 c. p.	300 ft.	315 c. p.
410 c. p.	400 ft.	350 c. p.
445 c. p.	500 ft.	365 c. p.
485 c. p.	600 ft.	380 c. p.
500 c. p.	700 ft.	400 c. p.
500 c. p.	800 ft.	400 c. p.
500 c. p.	900 ft.	400 c. p.
500 c. p.	1000 ft.	400 c. p.

RESULTS OF TESTS.

To completely cover the present state of the art, laboratory readings were made of practically all types of headlights now on the market, with an additional number of headlights made up of various designs of reflectors with concentrated filament incandescent lamps of various wattages as the source of light, making a total of about thirty headlights and two hundred combinations.

The illumination in foot-candles at the center and sides of the reference plane were plotted, and from these plots, considering only the center values of the headlight 9 ft. 7 in. above the rail, a series of headlights was chosen so as to cover in increments, variations from the lowest intensity oil to the highest intensity arc headlights.

The headlights chosen for the further tests were as follows, rated in accordance with the average of the center readings between 500 and 1,000 ft.:

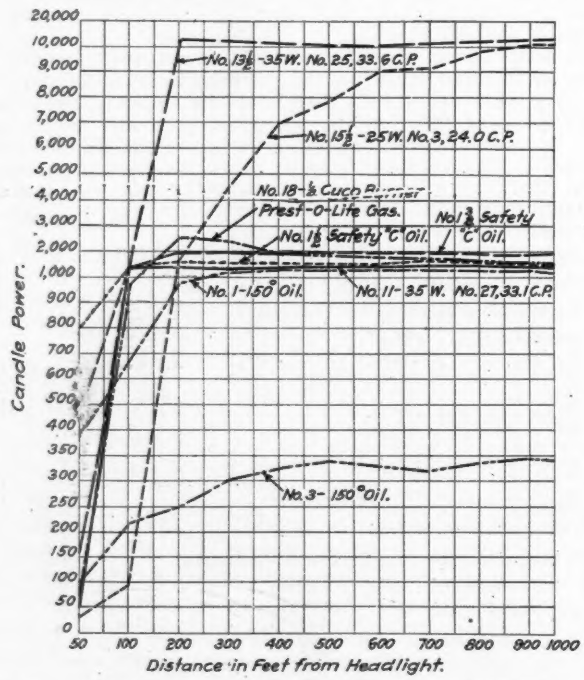
Headlight No.	Type	Source of Light	Average Apparent Beam Candle-power.
3	Oil	1⅛-in. burner	500
		150 degs. oil, felt wick	500
1	Oil	100-A burner	1,800
		150 degs. oil, cotton wick	1,800
18	Acetylene	¼-in. Cyco	1,800
		Prest-o-lite	1,800
1¾	Oil	100-A burner, safety	*2,500
		"C" oil, cotton wick	*2,500
1½	Oil	100-A burner	2,500
		150 degs. oil. cotton wick	2,500
15½	Incandescent	25 watts, 24 c. p. 6 volts	10,000
		Conc. Filt. Tung. Lamp	10,000
13½	Incandescent	35 watts, 33.6 c. p., 6 volts	30,000
		Conc. Filt. Tung. Lamp	30,000
19	Arc	26 amperes, 30 volts	60,000
		⅝-in. carbon and 9/16-inch. copper	60,000
21	Arc	8 amperes, 110 volts	150,000
		¾-in. copper and ½-in. magnetite	150,000
26	Arc	26 amperes, 30 volts	350,000
		⅝-in. carbon and ½-in. copper	350,000
22	Arc	25 amperes, 32 volts	1,000,000
		⅝-in. carbon and ½-in. copper	1,000,000

(*No. 1¾ headlight was not used in the original laboratory test. It was practically identical with the No. 1½, and the apparent beam candlepower is therefore given as 2500.)

In making the tests for visibility of dummies the lamps were carefully carried to the laboratory immediately after the tests and read for the intensity of the rays illuminating the center of the track.

ABILITY TO SEE OBJECTS AHEAD OF THE TRAIN

The headlights listed above were first tested to ascertain the distance at which dummies could be seen with the dummies standing abreast between rails. Three dummies were used—



Candle-power Curves—Headlights Used in Visibility Tests.

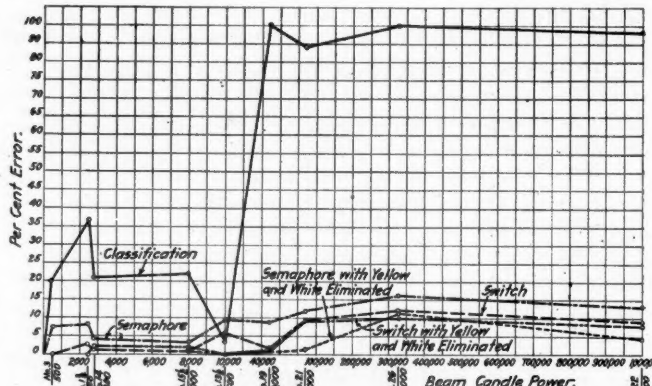
one dressed in dark blue overalls and jumper, known as the "dark dummy;" one dressed in blue and white striped overalls and jumper, known as the "medium dummy," and one dressed in white overalls and jumper, known as the "light dummy."

The ability to see dummies with lamps of moderate intensities is fairly well established by the visibility curves, and that there is no apparent difference in the ability to see dummies with a given intensity of light, whether the source is oil, acetylene or incandescent lamps. It will be noted, however, that with arc lamp No. 19, with 60,000 apparent beam candle-power, the dark object could be seen only 557 ft. Calculating from the visibility curve of the dark dummy for oil, acetylene and incandescent lamps, the dark dummy would be seen at the same distance with an apparent beam candle-power of only about 14,000. This effect can be attributed only to the predominance of short violet waves in the arc rays to which the eye does not readily respond.

From an examination of the data it is evident that there was only one headlight which will meet the 1,100-ft. requirement of one State with a sufficient margin to maintain this requirement in service, namely, headlight No. 22, and even this headlight will not meet the requirements of those States that call for 1,500 unreflected candle-power. The intensity of this headlight (1,000,000 apparent beam candle-power) is decidedly dangerous to railroad operation, as will be shown later; its only redeeming feature being the illumination of objects with sufficient intensity to render them visible to the engineman at some distance. In view of the fact that 800 feet is about the average distance at which an object can be seen on a clear dark night, this is a very doubhtful advantage, as it would be impossible for the engineman to apply the brakes in sufficient time to stop a fast train before hitting the object, even though he should be looking at the exact spot at the distance the object came into range of vision.

MISREADING OF SIGNALS

A second set of tests was conducted to ascertain the effect of these headlights upon the reading of semaphore lights,



Classification, Switch and Semaphore Errors—Opposing Headlight

switch and dwarf signals, fuses, red lantern set in the center of the track, red lantern swinging across the track, and classification signals. The tests were conducted both with and without opposing headlights. When opposing headlights were used they were of approximately the same intensity.

The classification lamp practically disappeared with an intensity of 40,000 apparent beam candle-power when using opposing headlights, and that serious errors in reading semaphore signals were made at and above 90,000 apparent beam candle-power, reaching at 12 per cent error at 330,000.

The above errors are taken from the curves in which the confusion of yellow and white signals is excluded, as the observers were not accustomed to the yellow signal, and practically all of the errors between yellow and white signals were the reading of yellow signals as white. Further, as there is no condition in railway operation where yellow and white signals are given in the same aspect, the errors are not of such a character that they should be considered in this investigation.

The phantom signals, that is, the reading of colored signals when there was no light in the semaphore lantern, began to appear with a beam intensity of 30,000 c.p., this error increasing up to 33 per cent. with an apparent beam candle-power of 1,000,000. With the No. 22 headlight, in 41 cases the red roundel in position in front of the semaphore lamp with the light not burning was read as a white indication, or in other words, the engineman got a phantom clear signal to proceed, when as a matter of fact the semaphore was set at danger or stop.

Table I shows serious failures in picking up red lanterns swinging across the track, and red lanterns located in the center of the track, running as high as a total of 45 failures with one of the arc headlights out of a total of 98 opportunities, and there were even a few failures to pick up fusees in the center of the track.

It was evident that phantom lights were being obtained with an apparent beam candle-power in the neighborhood of 20,000, and further, that the most serious effect of high intensity of light was the obscuring of danger signals on the

track, that is, red lanterns being swung across the track, red lanterns located in the middle of the track, and fusees. In order to fully establish the effect of the opposing headlight, a series of tests was conducted with opposing headlights on the night of October 30, for the picking up of danger signals in the center of the track only, three seconds being allowed to pick up the danger indication, which is considerably more time than enginemen generally have.

The headlights of these tests varied from 2,500 to 40,000 apparent beam candle-power. The results of these tests show that the percentage of errors varies from 0.67 per cent. at 2,500 apparent beam candle-power to 26.3 per cent. at 40,000 apparent beam candle-power. This means, in the case of 26.3 per cent. error, that out of 152 opportunities to observe there were 35 failures to pick up danger indications. None of the red indications above mentioned were at a distance greater than 1500 ft. from the observers, and it must be acknowledged that this extremely high percentage of failures is a very alarming and dangerous condition.

In order to check these results with the regular railroad observers, a duplicate set of tests was conducted on the night of November 3, except that in addition to the headlights used by the headlight committee, other tests were conducted with arc headlights, the maximum being 1,000,000 apparent beam candle-power in the opposing headlight. The errors varied from 8.3 per cent. at 2,500 apparent beam candle-power to 38.9 per cent. at 1,000,000 apparent beam candle-power.

Throughout the tests the percentage of error in reading classification signals was found to increase uniformly with the intensity of the opposing headlight.

Classification signals can be correctly determined up to a distance of 1,100 ft. with an apparent beam candle-power of 2,500, then gradually decreasing to 600 ft. at an apparent beam candle-power of 22,000.

With two trains approaching each other on a double-track road, the classification signals are just about obscured by the front end of the locomotive at 600 ft., so that even with an apparent beam candle-power of 2,500 the engineman has only 500 ft. (1100 ft. minus 600 ft.) in the movement of the two trains during which time he can pick up the classification signal. This is ample, but any decrease in the time represented by passing this 500 ft. wou'd be decidedly deterimental to the service.

All the tests indicate clearly that for picking up of danger signals, and the correct reading of classification and semaphore signals, the most desirable condition is the absence of any light on the front of the locomotive.

In the above discussion on misreading signals, we have been dealing with headlights of an intensity insufficient to be of much value in picking up obstructions on the track.

The only four functions remaining for which a headlight is required are as fo'lows:

1. Marker to designate the front end of a train.

2. Warning to the public and employees of the approach of a train.

3. Illumination of numbers on the headlight case.

4. Illumination of the track imediately ahead of the locomotive to allow an engineman to readily perform his duties while operating in and out of terminals, industrial sidings, switching in yard, and to readily pick up whistle posts, crossing and yard limit signs, etc., en route.

After weighing all the results, giving due consideration to the personal equation of the observers, the committee feels that the intensity of light represented by an apparent beam candle-power of 3,000 at the center of the reference plane 500 ft. to 1,000 ft. ahead of the locomotive, is as high as can be used without incurring undue liability of failure to correctly read signal indications and that this intensity of light will not have, in any noticeable degree, a blinding effect when shining in one's eyes.

The above described maximum headlight has considerable more intensity than is required to amply fill the four requirements stated, and it is recommended by the committee as the highest intensity which can be safely used. The minimum headlight, as given in the second part of the conclusion, is a headlight which the committee feels, from observation, gives an intensity which will amply fulfil the four requirements given above, and the range between minimum and maximum is sufficient.

It will be found that the conclusions of the committee are confirmed by practically all tests of headlights which have been conducted in the past few years.

The Columbus Tests, from which the committee has in the main drawn from their conclusions, show the dangers to be encountered in the operation of trains with high intensity headlights, or in other words, they show the potential for accidents which exists in the use of high intensity headlights.

The principal dangers to be encountered are due to opposing headlights and the opportunities for accidents on single-track railroads are very meager in comparison with the opportunities for accidents on lines where two, three, four, five and six tracks are used with automatic block-signals and where a much greater density of traffic obtains.

In this connection the committee refers the association to accidents reported by the Interstate Commerce Commission, in Accident Bulletins 14, 15, 28, 39 and 44. [The committee also quoted rules of various roads and city ordinances regarding high powered lights together with criticisms and suggestions made by officials. safety committees and employees of one road operating 1,100 electric arc headlights.—Ed.]

TABLE I.—SUMMARY LOCATIONS OF DANGER SIGNALS.

Test Number	Red Flag Reading	Red Flag Failures	Red Flag Distance	Red Lantern Reading	Red Lantern Failures	Red Lantern Distance	Fuses Reading	Fuses Failures	Fuses Distance
1-3/4C	21	0	1000-1200	28	1	1000	42	3	600-1050
3A	21	1	1000-1200	28	2	1000	42	0	600-1550
11B-C-D	0	0	0	0	0	0	0	0	0
11B-B	14	0	1200	0	0	0	35	3	600-1200
11N-J-K	0	0	0	0	0	0	0	0	0
13-1/2C-E-D	0	0	0	0	0	0	0	0	0
13-1/2C-C	14	0	1200	0	0	0	35	0	600-1200
13-1/2K	0	0	0	0	0	0	0	0	0
14-A-B-C	112	8	600-1100-1200-1500	77	2	1100-1200-1500	35	3	600-1500-1550
15-1/2B	35	3	600-1100-1200-1500	28	1	1100-1200	0	0	0
19-B	0	0	0	0	0	0	0	0	0
19-C-D	42	22	1100-1200-1500	56	23	1100-1200-1500	0	0	0
21-A-B-C	112	22	600-1100-1200-1500	77	19	1100-1200	0	0	0
21D	0	0	0	0	0	0	42	0	600-1400-1500
22A-B-C	141	17	600-1000-1100-1200-1500	77	16	600-1100-1200	126	2	600-1550
26A-B-C	105	21	600-1100-1200-1500	77	18	1100-1200	0	0	0
26D	0	0	0	0	0	0	21	1	100-1400

EQUIPMENT FOR TESTS.

Tests were conducted at the Columbus Shops of the Pennsylvania Lines West of Pittsburgh, Columbus, Ohio. from June 24, 1913, to December 31, 1913. The regular railroad observers and the men who did the most of the observing were as follows: Assistant train master; supervisor of signa's; ass't road foreman of engines and four enginemen.

As check tests, and to personally assure the committee of the results obtained, several tests as indicated were made with the following members or personal representatives of this committee: A. A. Ayers, C. H. Rae, M. K. Barnum, J. C. Little, Frank Zeleny, C. B. Smith, J. L. Minick, J. R. Alexander, and T. R. Cook.

To insure the fitness of the above men to act as observers, their eyes were tested by a man proficient in testing the eyes of enginemen.

A special laboratory was constructed in the Columbus Paint Shop, 45 ft. long, 30 ft. wide and 20 ft. high, the laboratory being lined and sealed to exclude outside light and painted flat black. A heavy adjustable elevating platform was installed in one end of the laboratory to obtain the correct elevation of the headlight for test points on the reference plane, at heights of both 12 ft. 7 in. and 9 ft. 7 in. above the rail. A heavy timber photometer trestle was installed 25 ft. ahead of the focal center of the headlight and at right angles to the center line of the beam. A sliding table on top of the trestle was provided and arranged to correctly point the field glass of the photometer at the focal center of the headlight, while the field glass was provided with a graduated sector to obtain the correct elevation. A Sharpe-Millar Portable Universal Photometer of the latest type was used.

For signal and obstruction tests an observation locomotive was constructed, consisting of a locomotive boiler placed on a flat car in its correct relative position to the rail. A series of eight seats, as close together as possible, to accommodate the observers, was erected so that the center of the seats would be in the

location of the engineer's seat, that is, the eight observers were seated symmetricaly and as compactly as possible about the engineman' seat. A door was provided in front of the observers which could be shut while the aspect to be obeserved was being changed. Brackets were provided on the head end of the boiler for the two positions of the headlights—12 ft. 7 in. and 9 ft. 7 in. from the top of the rail, and a hoist was provided for handling the headlights.

The test track where most of the work was done was the north shop track of Columbus Shop yards. The opposing headlight, with classification lamps, was mounted on a framework at the correct height and location to represent a locomotive approaching the observation locomotive on an adjacent track.

The laboratory tests of the selected headlights were checked by field tests at actual distances. The test field was immediately north of the shop test track.

There was another test track at Alton, about eight miles southwest of Columbus, where check visibility tests were conducted in order to insure that the results obtained on the test track at Columbus Shops were not influenced by physical surroundings.

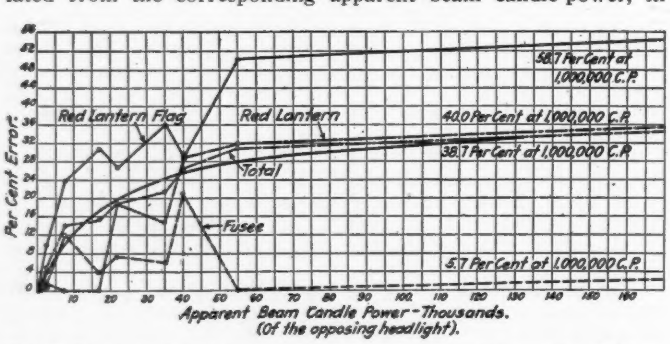
METHOD OF CONDUCTING TESTS.

Laboratory Tests.—All the headlight cases were mounted on wooden sub-bases of such dimensions that a standard distance was maintained from the front edge of the sub-base to the focal center of the lamp horizontally, and a standard vertical height was maintained from the bottom of the sub-base to the focal center vertically.

To insure constant intensity of the oil and gas headlights during the laboratory test, the center beam was occasionally read with the Bunsen photometer. The intensity of the incandescent lamp was kept constantly by continuous reading of the voltmeter and ammeter. With the arc lamps it was impossible to keep the intensity of the light constant, on account of the traveling of the arc around the carbons and variations in arc length. Continuous readings of the voltmeter and ammeter were taken and it was found that the energy supplied to the arc lamps was within a variation of 4½ per cent above and below normal.

In the laboratory work for ready reference, the stations in the reference plane were numbered; the 50-ft. station being No. 1, 100-ft. station No. 2, and the bench marks on the photometer trestle and adjustable platform for the headlights were numbered to correspond. Three readings were taken at each point to obtain average results, except in case of arc lamps, when ten readings were taken at each point as rapidly as possible.

The apparent beam candle-power was then calculated, using the exact distance from the focal center of the headlight to the horizontal axis of the field-glass elbow, and this apparent beam candle-power was plotted against the distance for the candle-power curves of the various headlights. At any given point on the reference plane the foot-candle illumination was then calculated from the corresponding apparent beam candle-power, in



Total Danger-signal Errors—Three-second Test—Headlight Committee and Regular Railroad Observers

both cases assuming that the law of inverse squares holds true.

It is further recommended by the committee that future measurements of headlights be made in a laboratory as described above, in order to have a common standard laboratory of sufficiently small dimensions that it can be erected at any railroad shop, and a range short enough to give foot-candle readings of sufficient intensity to be well within the range of correct reading.

Field Tests.—Tests were made in an open field with a few of the selected headlights to check the laboratory readings. An assumed elevation was taken for the height of the rail, and the location of headlight for the 9 ft. 7 in. height and 12 ft. 7 in. height was made in reference to this assumed elevation.

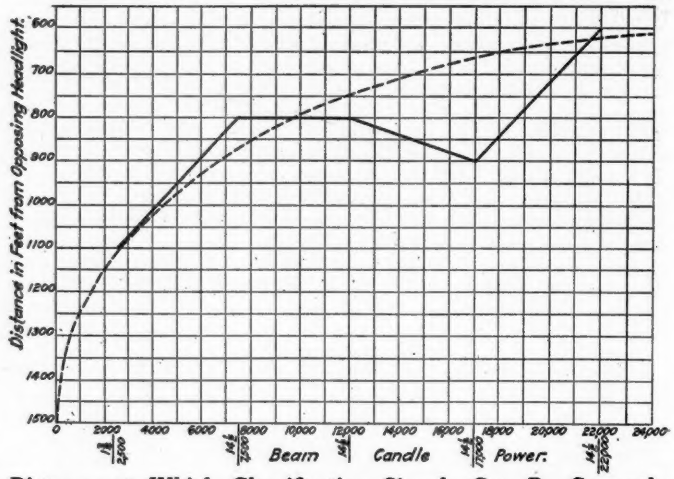
Dark nights, that is, nights without the moon, were chosen for the field tests, care being taken that there were no outside lights to interfere with the readings, and the readings were taken in the same manner as in the laboratory tests.

In the field tests the high intensity of the arc lamps gave foot-candle readings of sufficient intensity to be read accurately, and also of sufficient intensity to minimize the possibility of errors, due to outside general illumination, and it was found that these readings, in view of the extreme variation in the regulation of the arc, etc., checked closely with the laboratory results.

On account of the difficulty encountered in securing close checks between field tests and laboratory tests of the incandescent and oil headlights, it was thought desirable to repeat the field tests under conditions where the interference of atmospheric conditions, etc., would not obtain. These subsequent field tests check reasonably close with the laboratory tests.

Signal Lamp, Observation and Obstruction Tests.—With the exception of the tests made at Alton to check distances at which dummies could be seen, all these tests were conducted on the test track at Columbus Shops. The tests were conducted in the following manner:

The observation locomotive was stationed with the focal center



Distance at Which Classification Signals Can Be Correctly Distinguished

of the headlights at the zero mark, the observers being in their places with the cab door shut. The aspects to be observed, that is, the location of signals, position of the switches, opposing headlights, classification lamps and other obstructions or dummies, were arranged in accordance with a predetermined schedule. When the aspect was set up the man in charge of the observers was notified and he then turned out the light in the cab and the door was opened. The observers were given all the time they desired to note the observation, and the light was turned on with the door still open, and the observers made a record of what they saw. When this work was completed the door was closed and the locomotive moved forward 100 ft. for the next observation, advancing in 100-ft. movements to the 800 or 1000 ft. mark, depending upon the character of the test. The semaphore signals were 300 ft. and the opposing headlight 500 ft. beyond the 1000 ft. mark.

Visibility Tests—Stationary Dummies.—A series of tests was conducted with the selected headlights to determine the distance at which stationary dummies could be seen. These tests were conducted in the same manner as the "Signal Lamp," "Classification" and "Obstruction Tests." These tests were so conducted that no observer could tell the distances at which the other observers saw the dummies, thus entirely eliminating all chance of suggestion. Further, if there had been no dummies on the track, this fact could not have been known by the observers collectively, but only to each individual, as conversation or any indication of observations was strictly prohibited.

—*Visibility Tests.—Zigzag Dummies.*—These tests are described as follows:

The observation locomotive was stationed at the zero mark with the door of the observation cab open. A man dressed in white, blue and white striped or blue overalls moved toward the locomotive, starting at a considerable distance beyond the range of vision of the observers, and zigzagging back and forth from one rail to the other. He advanced 8 or 9 ft. while crossing diagonally from one rail to the other. As soon as any observer saw the dummy the fact was indicated by a blast from the locomotive whistle, thus stopping the dummy to make record of the distance and to collect observation sheets. Distances were not relayed back to the observers, but instead were noted in the field, thus the observers were unable to determine whether the dummy was advancing or receding.

The above routine was then repeated until all observers had

seen the dummy. Both the stationary and zigzag dummy tests were repeated at Alton.

Supplementary Tests of Danger Signals.—These tests were conducted in the same manner as the "Signal Lamp," "Classification" and "Obstruction Tests," with the exception that the observers were allowed only three seconds to make the observations, that is, when the aspect was ready the light was turned out in the cab and the door was opened for three seconds and then closed, during which interval the observers looked for the danger indications. All of the above tests were conducted on the Columbus Shop track, and were conducted with opposing headlight having intensities equal to the intensity of the corresponding headlight on the observation locomotive. Not more than two danger indications, out of a possible three, were used at any one time, that is, there might have been one or two or none, the observers merely looked for indications which were always located between the rails. The three danger indications used in these tests were: a red lantern located in the middle of the track, fuses burning in the middle of the track, or a red lantern swung across the track.

RESULTS OF TESTS.

Laboratory Tests.—In these tests all the headlights were used in various combinations. An analysis of the results shows conclusively that there is practically no difference in the illumination on the reference plane with the headlight located at a height of 9 ft. 7 in. as compared with the height of 12 ft. 7 in. above the rail.

The No. 1½ headlight with 150 deg. oil and 100-A burner shows the same results for the plain reflector with a 5-in. hood and a reflector provided with a Mangin mirror. The results indicate that, as far as the center readings are concerned, they are practically constant at 200 ft. and beyond, the 200 ft. mark corresponding to an angle of 1 deg. 11 min. from the axis of the beam.

In the tests with the incandescent lamps it was found that with the concentrated filament tungsten lamp, the candle-power readings were not consistent with the candle-power of the bare lamp. With the No. 13½ headlight a higher apparent beam candle-power was obtained with the No. 7 lamp, giving 20.4 c-p. at 20 watts, than was obtained with the No. 25 lamp, giving 36.3 c-p. at 35 watts. The variations in readings led to some investigation of lamp filaments. In these tests the apparent beam candle-power of the headlight varies consistently with the unreflected candle-power of the incandescent lamp, the lowest apparent beam candle-power being made with the No. 61 lamp, 15 watts, 12.3 c-p., and the maximum apparent beam candle-power being obtained with the No. 71 lamp, 20 watts, 28 c-p.

In a test of two arc light headlights, Nos. 19 and 22, of approximately the same design and wattage, one gave an average apparent beam candle-power about twenty times that of the other. This difference, together with the excessive variations in readings for the individual headlights, indicates that very erratic performance may reasonably be expected from such headlights when in regular operating service where they can not be given as careful attention as they received during the Columbus Tests.

In connection with the laboratory tests, candle-power readings were taken of various sources of light, without the aid of a reflector, these readings consisting of the average of a number of readings taken in the horizontal plane.

Visibility Tests.—In the preliminary test there was found to be considerable variations in the distances at which dummies could be seen on different nights with the same headlights, although on all occasions it was the endeavor to maintain a constant apparent beam candle-power of the various headlights by the proper adjustment of the sources of energy. In order to ascertain whether the conditions of the shop tracks were comparable to the conditions in the open country, two tests were run with the headlight committee acting as observers, one on the shop track and one in the open country at Alton.

In view of the variations in the apparent beam candle-power of these headlights the readings check about as close as can be expected, with the possibility that the conditions surrounding the shop test track might have been less favorable than the conditions at Alton. Even these slight differences in conditions would not, in the judgment of the committee, have made any appreciable change in the results.

The tests are of interest: first, from the point of view that they give distances at which obstructions were located when the observers were not looking particularly for these obstructions; and secondly, the tests show an interesting feature between low and high intesity lights, in that with the high intensity lights the glare of the opposing headlight prevented the observers from locating the dummies at anywhere near the distances obtained in the visibility tests without opposing headlight, while with the low intensity lights the observers were able to locate the dummies at greater distances than they did in the visibility tests without opposing headlights.

Signal Lamp, Observation and Obstruction Tests.—These tests were conducted with the regular railroad observers on semaphore switch, classification lamps, danger indications and obstructions, making note of all data required.

Undoubtedly in all tests of this kind, where the observations by men are required, there is liability of personal error, and the greater the number of tests the less bearing this feature will have upon the results. With this fact in mind, the errors of the headlight committee on danger indications made on the night of October 30, and those of the regular railroad observers made on the night of November 3, were combined. To further eliminate errors, the errors obtained with the three danger indications are combined in a total average curve; in addition a smooth curve is drawn through the points of the total average curve, showing the average error of reading red indications and increasing apparent beam candle-power in the opposing headlight. This indicates no errors without an opposing headlight, the curve increasing to about 40 per cent with 1,000,000 apparent beam candle-power in the opposing headlight.

Outdoor Tests Supplementing Field Tests.—As stated in the discussion of field tests under the heading of "Method of Conducting Tests," it was decided to make some additional tests under more favorable conditions, and a set of tests was conducted at night in the foundry of the Buckeye Steel Castings Company, at Columbus, Ohio, this foundry being about 1,150 ft. long, 70 ft. wide and 40 ft. high.

The following headlights were tested: Nos. 1⅞, 1½-A, and 14½-A.

The oil headlights were tested in two ways: first, with the axis of the beam parallel with the track; and second, with the front of the headlight tipped up ⅝ in. Headlight No. 1⅞ was at practically the maximum recommended intensity. The readings of the oil headlight were approximately 20 to 25 per cent under the laboratory readings. The incandescent headlight, No. 14½-A, shows the 100 and 200 ft. readings in the field tests less than the laboratory tests, while the 300, 400, 500, 600 and 700 ft. readings are greater than the laboratory tests.

A further test was conducted at Altoona with incandescent lamp headlight No. 11 to determine whether the law of inverse squares is applicable to the beam of light given by headlight having a parabolic reflector. The lamp was so adjusted in the reflector as to give the narrowest possible beam, that is, it was attempted to secure a beam of parallel rays.

Reducing the foot-candle readings to apparent beam candle-power on the assumption that the law of the inverse squares was applicable, gave an average apparent beam candle-power of 44,800 with a maximum variation above this average of 7.15 per cent and 9.59 per cent below. As the personal error of reading a photometer is about 5 per cent there is a maximum error of about 4½ per cent unaccounted for in the above. This 4½ per cent error may be due to any or all of three causes, as follows:

1. Inaccuracies in setting up the photometer in such manner as to read the same ray at each station.
2. The ammeter used in conjunction with the photometer reference lamp had a very small scale and it was difficult to read current to more than three decimal points.
3. The foot-candle scale on the photometer is such that in reading low candle-powers it is difficult to read to three decimal points.

These three possibilities of error, combined with the fact that in the low foot-candle readings it was necessary to use a screen in order to get any readings, and when considered in conjunction with the field tests noted above, make it appear safe to assume that the law of inverse squares is applicable to headlights of this character.

As to the comparison of the oil headlights, No. 1⅞ and No. 1½-A (without mirror), that is, the headlight equipped with the mirror reflector and the one not equipped with the mirror reflector, the results of tests show conclusively that there is no difference in the character of the light from the two headlights in question, the only difference being that the No. 1⅞ gave an apparent beam candle-power about 20 per cent higher than the No. 1½-A. (without mirror).

[The committee included in the report comments of other headlight tests made during the past five years.—Ed.]

A circular of inquiry was sent out by the Headlight Committee. The replies were compiled both as to the individual railroad answering, and as to the number of headlights represented by the railroads replying, and the same relative order of importance in both the compilations is as follows:

1. To warn employees and the public of the approach of a train.
2. To permit enginemen to observe wayside objects, such as whistle posts, landmarks, etc.
3. A marker to designate the head end of a train.
4. To display locomotive or train numbers.
5. To illuminate objects a sufficient distance ahead of the train to avoid striking them.

Any headlight between the minimum and maximum require-

ments as outlined in this report will satisfy the first four of the above functions, and will satisfy the fifth condition in so far as shifting locomotives are concerned in and around railway terminals, yards and sidings, and will not cause appreciable errors in the reading of signals; and the committee feels strongly that any headlight in excess of the recommended maximum of 3,000 apparent beam candle-power will cause serious errors in the reading of signals.

The report is signed by:—D. F. Crawford (Penn.), chairman; A. R. Ayers, (N. Y. C.); C. H. Rae, (L. & N.); H. T. Bentley, (C. &. N. W.); F. A. Torrey, (C. B. & Q.); M. K. Barnum, (B. & O.); and Henry Bartlett, (B. & M.)

After reading the report, Mr. Crawford added:

In making this headlight test, it was the endeavor of the committee to put before you as complete data as possible in the time permitted. We had about forty men working at one time on this work. Every effort has been made to present to you data that is accurate, based on the best methods of obtaining such data that is known, and to give you the results of experiments made at the Columbus shops of the Pennsylvania lines, as well as field tests made on the road. We have endeavored to give you information collected from other sources, and also have given in the report some extremely interesting and important information from one of the roads that has recently equipped a number of locomotives with high powered headlights.

My experience in observing locomotive headlights started in 1909. At that time I observed with my own eyes effects of a high powered headlight that compel me to say before this assemblage that I regard it as the most dangerous piece of apparatus that can be put on a railroad, the danger increasing in some proportion to the number of tracks, the number of trains and the number of signals. I do not say that every locomotive equipped with a high powered headlight is going to have an accident, but I do say that I am convinced from the results obtained in the experiments included in this report, and from the two sets of experiments in which I took part personally, that a high powered headlight has a potential factor of danger which the American railroads must not overlook. I do not wish to exaggerate, but I cannot conceive of any more serious proposition than putting these high powered headlights on a four track railroad.

I had hoped that I would be able to ask that the committee be dismissed, but it is very desirable that the committee be continued. There will be ample work for such a committee, and one of the first things that committee should do is to determine and agree upon method of measuring and recording the measurements of socalled locomotive headlights. A scrutiny of the laws of the several states which are included in an appendix to the report will indicate clearly to you that the gentlemen in these states who had to do with the making of the laws were very much at sea as to how to measure the power of a headlight.

There are several errors in the report, typographical and others, and I should like to ask that Mr. Minick of the Pennsylvania railroad, one of the gentlemen who has been very intimately connected with its preparation, be given the privilege of the floor so that he may state to you the errors that he has discovered and give you a little further analysis that he has been able to make.

J. L. Minick (Penna. Lines): The report was worked up in rather quick time. The actual work of taking the readings and investigating the headlights covered some four or five months, and the writing of the report took probably six weeks, consequently the analysis of the test results is not as complete as it could have been made if we could have had as much time in analyzing the results as we had in making the tests. On account of the limited time at our command we necessarily took each matter up, one at a time, and when each matter was worked out we considered, that so far as the report was concerned, it was complete. One of the most important tests was that of determining how far an object on the track could be seen by the use of headlights of different candle-powers. The actual results of the tests are plotted in distance against foot-candles. Foot-candles is the scientific term used very largely by lighting people and no doubt is unknown to a good many of you. In that respect, the report is somewhat confusing. I have taken that same data and reproduced it on the basis of apparent beam candle-power. The curve is much easier to read, on account of the higher value; I wish to offer this to the committee, and if they think it wise they can have it published in the report, when it is finally incorporated in the proceedings.

There are two or three matters I should like to have discussed by the members of this association. The committee asked for a vote of the membership of the Association on "what are the functions of a headlight?" and "what are their relative importance?" This matter is rather a serious one, and I should like to have it discussed by the Association. If it is the pleasure of this association to continue the committee, there are several things that can and should be done as quickly as possible. There is not only the question of standardizing or determining an agreed upon method for rating a headlight, but the question of size and shape of lamp, the voltage, and features of that kind should be determined upon. The manufacturers of incandescent lamps, provided an incandescent lamp is used, are very much at sea as to what the railroad people actually want. The size and shape of the filament will have a lot to do with what is desirable. There are a few typographical errors in the reports. I do not think it is hardly necessary to call them to your attention.

DISCUSSION

D. F. Crawford: It seems very strange, gentlemen, that the same people who are agitating so strongly high powered headlights for locomotives are equally strong in denunciation of high powered lights for automobiles. The director of public safety of the City of Pittsburgh has recently asked the City Council for an ordinance to prohibit all electric arc lights on street cars, and all high powered lights on automobiles. The City of New York prohibits them. Also, the City of Washington. I was there on January 16th, appearing before the House Committee on Interstate and Foreign Commerce on the subject of headlights, and I was very much interested to read in the Washington evening papers that same evening a protest from the citizens of the City of Washington as to the danger of high powered lights on automobiles and street cars on the city streets.

W. H. Corbett (M. C.): About a year ago the City of Chesterton, Indiana, put in arc lights and one of their lights which was located a mile and a half back from a block signal, but directly in line with it, was so strong that the men could not tell the composition of that light, whether it was white or whether it was gray. The engineers asked that the light be removed, or else that the company change the position of the block signal. I think that goes to prove to you that the high powered lights do interfere with the enginemen locating and knowing the proper lights on a signal. While running a locomotive, passing through a very thick fog, or snowstorm, I would much rather have no light at all on the locomotive, even the oil light, if I desire to see ahead, because the light banks up against the fog, and you cannot see anything beyond. It means that the engineer must look out the side window and note the objects along the route to tell where he is. These are actual experiences, gentlemen, that I know.

T. R. Cook (Penna. Lines): I would like to emphasize one point Mr. Minick brought out, and that is regarding the sense of this convention as to what are the requirements of a headlight. The committee was very much at sea, and I imagine we all are, in making a definition of what is considered the maximum and minimum. Now, in speaking of a high powered headlight, we refer principally to the arc headlight. That gives about a million paraffin candle-power. That is not a high powered light in comparison with the searchlight used by the Navy, and in the present state of the art, you can get a high powered headlight with the new nitrogen lamp. You can get a light that will give in the neighborhood of 5,000,000 paraffin candle-power with very little energy. We found one remarkable thing on the tests, and that was that the enginemen engaged in the tests apparently did not care for the high powered beam. One night we had a headlight that was giving a very good side illumination, and I asked the enginemen what they thought about it. They considered it was a good headlight. Immediately after that we put on a light which had about ten times the beam candle-power, with a straight beam, and all four enginemen shook their heads, and did not care for it. The enginemen are very liable to be deceived on this question in that the present high powered headlights, especially the arc headlights, give a good side light. It is possible that the desire of the enginemen to have high powered headlights is merely a question of lighting up the right of way on both sides of the track, and your committee in their recommendations have given particular attention to the side illumination, which is the hardest thing to get in the headlight.

Wm. Alexander, (C., M. & St. P.): The Chicago, Milwaukee & St. Paul has in operation at the present time about 1600 electric headlights. In the State of Wisconsin all the road locomotives have been equipped since July 1, 1913. In the other States the equipping of the locomotives has been going on for the past three or four years. During the six months' period of which I have data, from October 1. 1913, to March 31, 1914, in the State of Wisconsin, we had fifty-seven delays to trains on account of electric headlight failures. Thirty-six of these delays were to passenger trains and they averaged 17 minutes per delay. There were 21 delays to freight trains, the average time delayed being one hour and one minute. During the period referred to,

in the State of Wisconsin only, there were 308 road engines equipped. I went back to the year previous and compared these figures with the failures which resulted in train delays when we were operating with oil headlights, and I found that we had 6 delays. This does not mean that we had only 6 failures to the oil lamps, but it means there were only 6 delays. In analyzing the failures and delays I have come to the conclusion that the reason we have more delays with electric headlights is because the enginemen after they have become used to running with the electric headlight, want to stop just as soon as something happens to the electric headlight, whereas, with the oil headlight they were used to depending more upon signal indications and not so much on their electric headlight and will proceed without causing a delay, or put a lantern in the headlight and proceed in that manner.

I personally had considerable experience riding on locomotives equipped with electric headlights. I also worked on the tests which were made for the Wisconsin State Commission two years ago, at Madison, Wisconsin, and all my experience and all the tests that were made at that time bear out the report of this committee in relation to the phantom lights, the misreading of signals, etc.

M. K. Barnum (B. & O.): There are three facts brought out in this report which impressed me especially, and I believe it is worth while to call them to the attention of this meeting. The first of these facts is that with a headlight having a beam candle-power of over 25,000, about 20 per cent of phantom lights were developed. The second fact is that with an opposing arc light about 39 per cent of the red flag signals ahead of the engine on which the observers were located were obliterated or missed, so they were not seen at all. On roads with two or more tracks that possesses a serious element of danger. The third fact is that none of the arc lights tested showed a beam candle-power of over about 1000. I want to correct that; it was not beam candle-power; it was candle power unaided by the reflector. A very careful distinction should be made between the terms "beam candle-power" and "candle-power unaided with the reflector." This test indicates that there has not been up to this time on the market any arc light that would meet the laws of those states calling for "1500 candle-power unaided by reflectors." Railroads think they are complying with those laws, but lack 33 1-3 per cent of coming up to them. Those three points should be made conspicuous.

C. F. Giles, (L. & N.): It is customary, in receiving such reports, to authorize their publication in the proceedings of the Association, but I would move that it be published in a separate volume, so it would be available for the use of the representatives of railroads before bodies such as railroad commissions. (The motion was carried.)

R. P. Blake (N. P.).: I would like to ask the members of the committee if I understood correctly that, in making that observation test of signals, they allowed a three seconds' interval of observation at all light intensities?

D. F. Crawford: That is correct.

R. P. Blake: Do you think that was perfectly fair, bearing in mind the fact that the focus of the eye would not be exactly the same at the higher intensities of light? It is a fact that riding behind an electric light you cannot always look out and adjust your eye to observe the signals in front of you as quickly as you can with a smaller light.

D. F. Crawford: Three seconds was thought to be the time the man would have to observe, and as he cannot wait until he focuses his eye to read a signal, the length of observation was made three seconds. A longer interval of observation with some of the higher intensity lights would have given a lower degree of error, but would a longer interval to read and realize a signal have prevented an accident?

C. E. Chambers (C. of N. J.): I think it would be criminal for a four-track railroad with a heavy suburban traffic to undertake to operate high-powered headlights.

C. D. Young (Penna.): There is a field, under certain operating conditions on some railroads, where high powered lights can be used with some degree of safety and perhaps to advantage, but those localities are few. They are only on branch lines where the traffic is very thin, and operation is practically without meeting points. Under those conditions there have been cases due to heavy rains or landslides, where accidents have been prevented. I think this is a subject which should be handled by the railroads who are operating the trains within the States. I do not believe it ever should have been a subject for legislation. It is a technical question, a question of operation, and one which should be left to the railroads.

E. W. Pratt (C. & N. W.): I have been on a locomotive with enginemen that were experienced in the use of the electric headlight, when in approaching a meeting point and a coal shed, they were misled exceeding a distance of a quarter of a mile in making their stop for the coalshed.

C. H. Rae (L. & N.): In the past six years I have appeared before legislative bodies on this headlight proposition in the States of Ohio, Indiana, Illinois, Kentucky, Tennessee, Alabama, Louisiana, Mississippi and Georgia. Of course, the Brotherhood of Locomotive Engineers advocates the high powered headlight and I find this was brought about by the negligence of the railroads in keeping up their headlights, not keeping their reflectors well-plated, and using poor oil. Invariably when we appeared before the legislative bodies, the chairman of the Legislative Board of the B. of L. E. would charge that the railroads have made no effort to improve their lights and use good oil; that there are smoky chimneys and the reflectors are in bad shape. They get the sympathy of the committees when they state that. Where the committees have been given the proper information concerning headlights, we have, as a rule, been successful in defeating the bills. We defeated the bills in all the States I have made mention of, except in Illinois, where we had a compromise bill, and the State of Georgia and the State of Mississippi.

S. G. Thompson (P. & R.): I would like to know whether the committee has any information that would give the members of the Association an idea as to how the minimum requirements of the committee's recommendations compare with the headlights which we have on the locomotives now. I believe that the one we have will not meet the minimum requirement; that is, it will not pick up a man in dark clothes on the road 300 or 400 feet ahead. Possibly you could not see him 200 or 250 feet ahead, and it may be that you could not see him 150 feet ahead.

T. R. Cook: With a 1,000 beam candle power headlight you can see a man with dark clothes 230 ft. away, a man in light clothes 600 ft. away. As you drop that lamp from 1,000 c.p. to 500, the dark man will drop from 230 ft. to in the neighborhood of 175 ft. and the light man from 600 ft. to approximately 475 ft. You will be able to see whistle post and similar objects probably a greater distance than you would the white object, as they present a flat surface to the light, and you get greater reflection. With a 3,000 c.p. headlight you can see a man with black clothes about 500 ft.

LOCOMOTIVE BOILER CONSTRUCTION

The Committee on Design, Construction and Maintenance of Locomotive Boilers were not able to present a report this year on account of the press of other association business. The subject was continued and the membership of the committee left in the hands of the incoming executive committee.

STANDARDIZATION OF TINWARE

The committee has studied principally the method of construction and the material to be used; it has also selected the dimensions that, in its judgment, will be most suitable for the service for which each article will be used. As an illus-

M. D. Franey
Chairman, Committee on Standardization of Tinware

tration, it is well known that a tank bucket has to withstand very severe usage. For this reason your committee is recommending a tank bucket with a bottom of very small diameter, designed with a specially formed wire guard fastening the bottom in place. The bottom of the bucket is also depressed so that it can set over a projection without injury. This form of construction will very successfully withstand the service and the force of a blow to which the tank bucket is subjected.

The committee has endeavored to reduce the number of articles used to a minimum, and finds that a number of roads get along with the articles mentioned in this report.

Before reviewing the design and construction of the articles to be manufactured, it might be of interest to review some of the commercial terms applied to the tin used in construction. the time when high-grade tin plates were made from charcoal iron and lower grades from coke iron; hence, plates with lighter coating are called "Coke Tin Plates."

Number.	Lb.	Number.	Lb.
38	55	31	90
37	60	31	95
36	65	30½	100
35	70	30 IC	107
34	75	29	118
33	80	28 IX	135
32	85	28 IXL	128
28 DC	139	25 4X	195
27 2X	155	25 4XL	188
27 2XL	148	24 D2X	210
26 3X	175	23 D3X	240
26 3XL	168	22 D4X	268
26 DX	180		

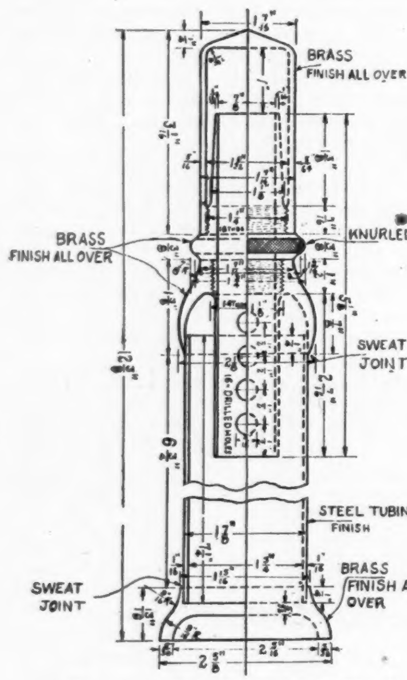


Fig. 1—Steel Engineer's Torch

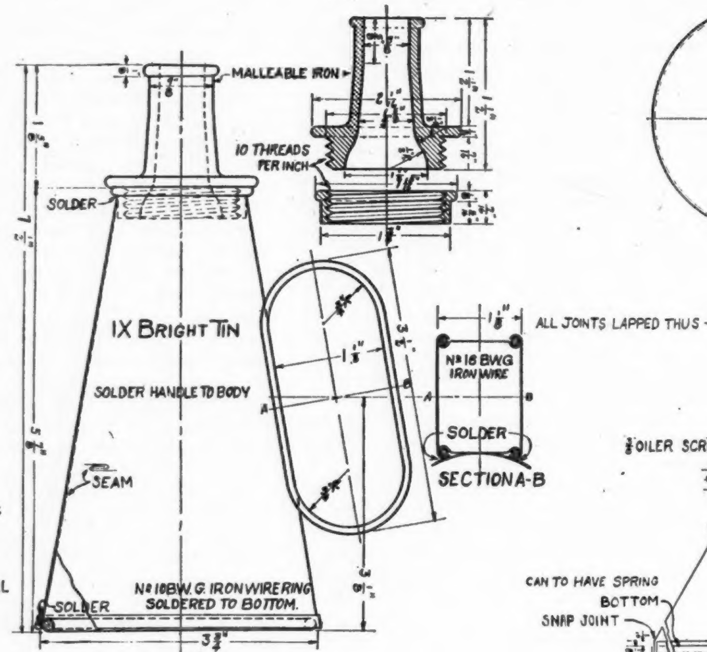


Fig. 2—Tin Engineer's Torch

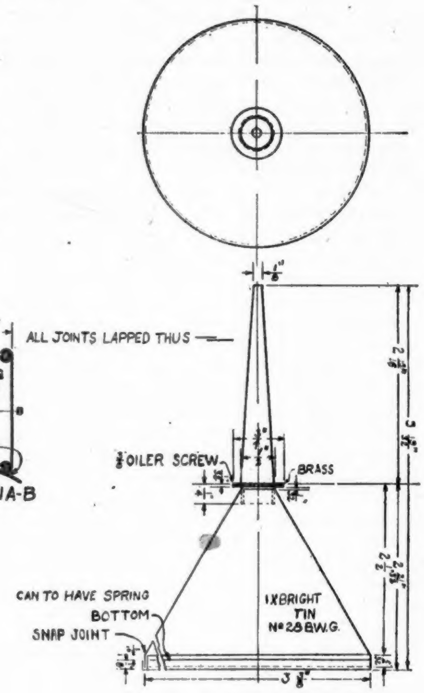


Fig. 3—Squirt Oil Can

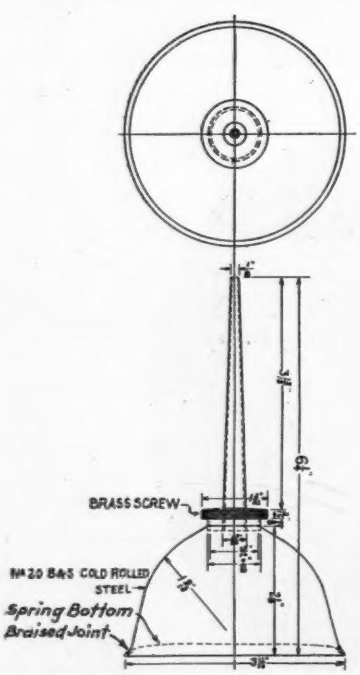


Fig. 4—Steel Squirt Can

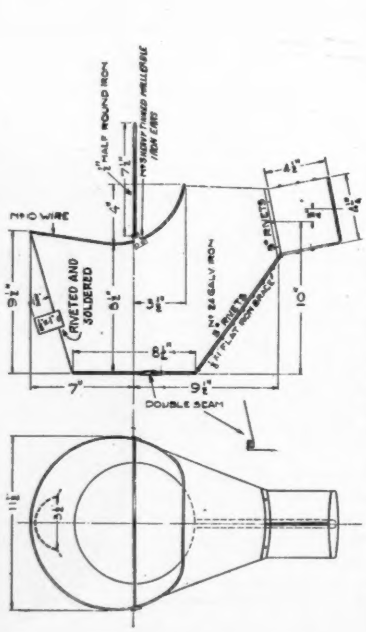


Fig. 5—Sand Bucket

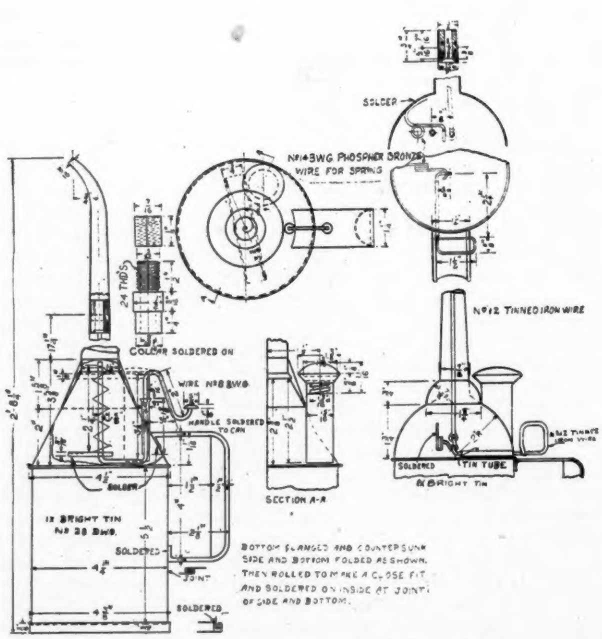


Fig. 6—Three Pint Spout Oil Can

The plates are referred to as "Coke Tin," "Charcoal Tin" and "Terne Plates."

Coke Tin Plates.—The base of these plates is the best soft steel, made especially for tin plating. The word "Coke" is a trade term, indicating finish. The trade has retained it from

Standard Weights and Gages.—Tin plates are generally packed in boxes, and the unit of value and measurement is known as a base box, which is 112 sheets of 14 in. by 20 in., or 31,360 sq. in. of any size.

Charcoal Tin Plates.—The base metal of these plates is spe-

cially prepared with a view to securing a high gloss and fine working quality. The trade term "Charcoal" is referred to in the description of "Coke" finish. It is customary to distinguish the amount of coating and degree of finish by letters "1-A," "2-A," etc., up to and including "5-A." "1-A" grade has the least amount of coating, and each "A" signifies an additional quantity.

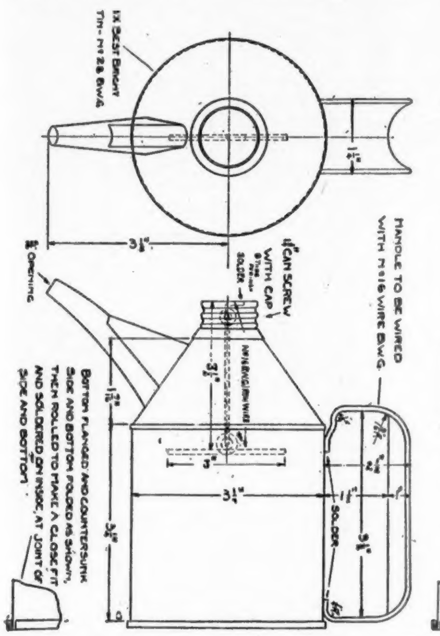


Fig. 7—Pint Signal Oil Can

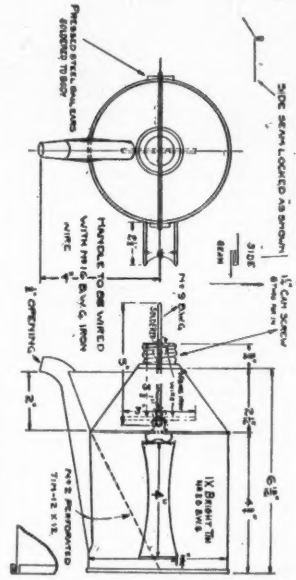


Fig. 8—Three Pint Valve Oil Can

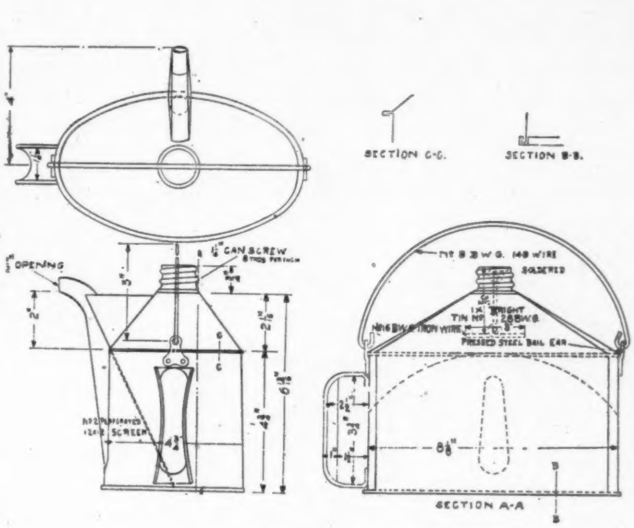


Fig. 9—Five Pint Valve Oil Can

One of the leading manufacturers gives the following tabulation for various brands, showing the approximate weight of coating on both sides of the sheet per base box of 112 sheets, 14 in. by 20 in. For 112 sheets, 20 in. by 28 in., the weight of coating would be double that shown in the following table:

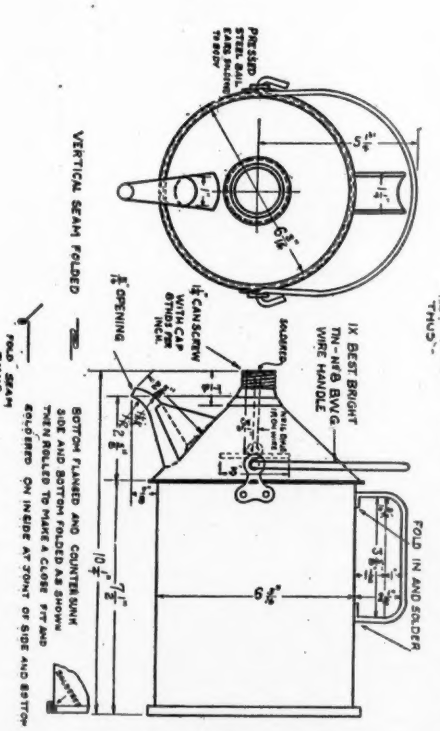


Fig. 10—Gallon Oil Can

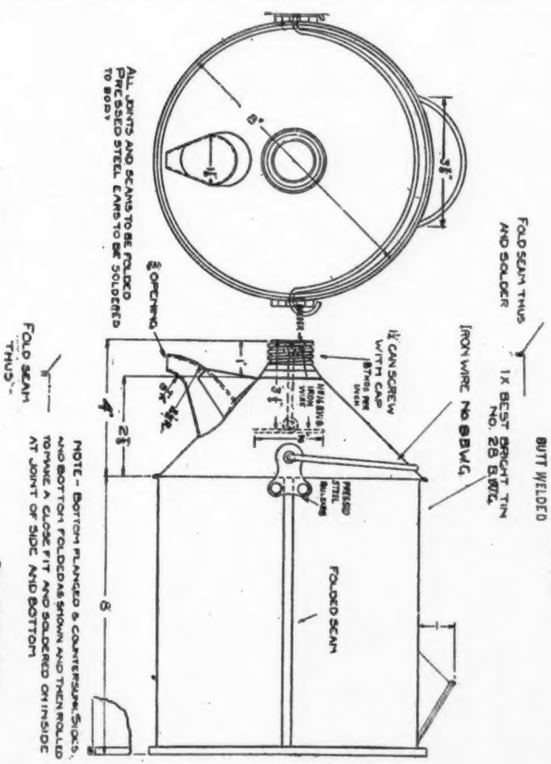


Fig. 11—Two Gallon Oil Can

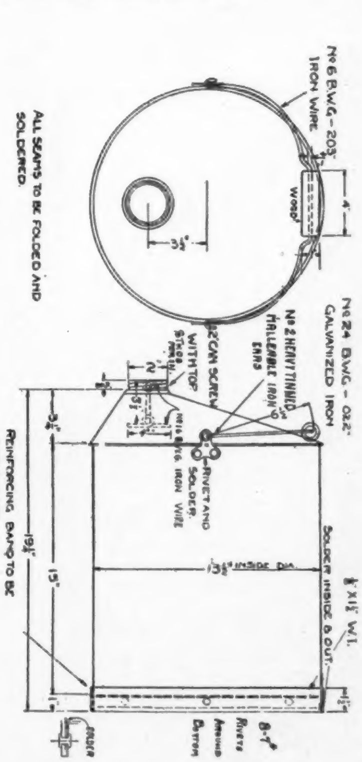


Fig. 12—Ten Gallon Oil Can

1-A Charcoals	3 lb.
2-A Charcoals	3½ lb.
3-A Charcoals	4 lb.
4-A Charcoals	5 lb.
5-A Charcoals	6 lb.
Premier	7 lb.

They recommend the Premier brand as suitable for all high-class work, such as nickel-plating.

Terne Plates.—Terne plate, which is generally known as roofing tin, is a product made by coating steel or iron sheets with a mixture consisting of approximately 25 per cent. tin and 75 per cent. lead. These plates are made from copper bearing open-hearth steel. The manufacturers claim that steel of this character amalgamates with the tin and lead mixture in such a manner as to produce a better plate than is possible with ordinary steel, and as a consequence resists corrosion to a remarkable degree. It is also as soft as the best charcoal iron.

The process of manufacture does not produce all perfect sheets, which are designated by the mill as "Prime" plates. A small percentage of the manufactured plates contain pinholes or other defects, and are called "Wasters." When prime plates only are desired, the mill charges a premium for such distinction.

Case or Package Marks.—The cases should show the brand and thickness; erasure of any stencil mark placed on the case by the manufacturer should be promptly noted as requiring careful inspection of contents.

In the prints submitted the committee has endeavored to cover every detail, making parts interchangeable where this is practical. It will be noted the joints are double-seamed and the detail of the seam is carefully outlined. The material is specified, standard kettle ears are used, handles are wired for stiffness and the diameter of the wire is in proportion to the capacity of the article, the can tops are interchangeable in groups, and the spouts are carefully braced to withstand rough service. The following is a brief description of each part recommended:

Fig. 1 shows an engineer's torch that is used on one of our railroads. They claim to be getting very good results from it. The special feature of this torch is a cap which screws over the top and prevents oil wasting out into the seat box when the torch is not in use. This feature makes it very popular with the enginemen. While this torch is not tinware, it is used as a substitute for tinware. Its attractiveness makes it an economical proposition because few are used as compared with the ordinary tin torch, and a saving is thereby made.

Fig. 2 shows a very satisfactory form of torch, used on some roads.

Fig. 3 is a squirt oil can made of tin.

Fig. 4 is a pressed steel squirt oil can, which can be purchased in the market, and is merely shown as an alternative where such a can is desired.

Fig. 5.—Sand bucket.

Fig. 6 shows two forms of long-spout engine oil can in quite general use. It is claimed that the amount of oil saved by the use of these cans will pay for the cost of construction.

Fig. 7 is a one-pint signal oil can. This is furnished on the engine, principally in winter weather, to carry a small amount of oil for emergency use. It is made small and compact to withstand rough usage and to save material.

Fig. 8 is a three-pint valve oil can with an internal strainer made of perforated tin. The opening in the top is made small to require the heating of the valve oil before putting it in the can so that it will readily strain through the perforations.

Fig. 9 shows a five-pint valve oil can, constructed along the same lines, except the elliptical construction. The purpose of this form of construction is to give a large capacity oil can, placing the handle on the side, enabling same to be used in a minimum of space between the lubricator and the roof of the cab.

Fig. 10, one-gallon can, of similar construction. Both of these cans are made the same diameter, which will permit using the same dies in construction.

Fig. 11 is a two-gallon oil can, similar in construction to Figs. 8 and 9.

Fig. 12, ten-gallon oil can, made of galvanized iron, has the bonnet so constructed as to permit of a free outlet for the oil. The iron band riveted to the flanged edge of the bottom protects the can from rough usage.

The five-gallon and three-gallon cans are constructed along similar lines.

Fig. 13 is the two-gallon tank bucket referred to in the first part of this paper.

Fig. 14 shows two designs of sand buckets, where such an article is necessary.

Fig. 15 is a recommended form of sponge bucket for engine house use. This bucket has a capacity of four gallons or fifty pounds of saturated sponging. It is made elliptical for convenience in carrying, and will hold enough sponging to pack one side of a Pacific type engine, trailer and engine trucks. It is suggested that two buckets be used, one to contain the new sponging and one to receive the old waste removed from the boxes. The size of the buckets is made large to avoid unnecessary trips from the draining vat to the engine being packed.

The report is signed by:—M. D. Franey, (L. S. & M. S.), chairman; J. C. Mengel, (Penna.); W. C. Hayes, (Erie); J. A. Carney, (C. B. & Q.), and S. L. Bean, (A. T. & S. F.).

DISCUSSION

The Secretary: I move that the report of the committee be received, and that the matter of the continuance of the committee be referred to the incoming executive committee.

M. K. Barnum (B. & O.): I think the attitude taken in this report is a mistake, and I want to take exception to the view that we cannot adopt standards for tinware for both locomotives and general service in the mechanical departments of the railroads. I think that would be one of the easiest things for us to standardize in all the railroad departments and I would not be willing to approve that part of the report. I think the rest of the report is very well presented, but would take issue with the committee on that particular point. I move that the committee be continued and instructed to bring in a report next year with recommendations for standards for all classes of tinware now in use.

(The motion was carried.)

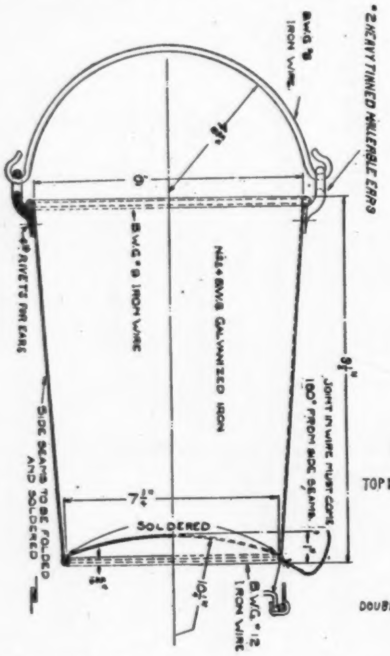


Fig. 13—Two Gallon Tank Bucket

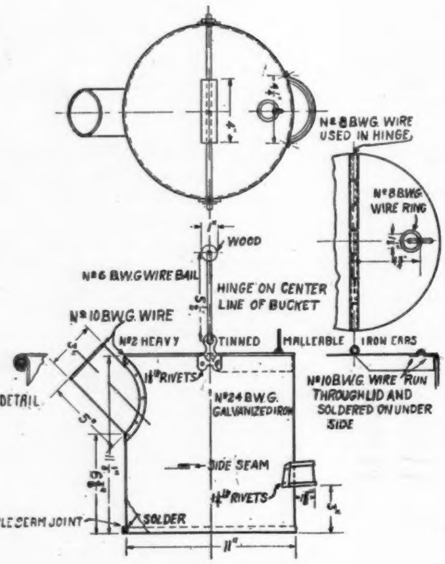


Fig. 14—Sand Bucket

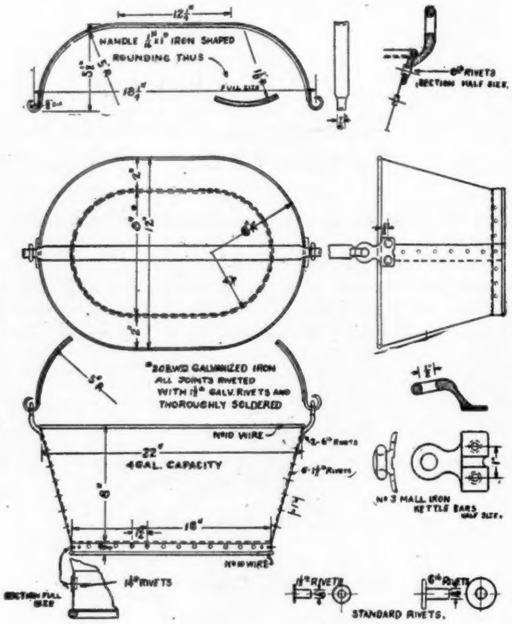


Fig. 15—Sponging Bucket for Engine House

SUPERHEATER LOCOMOTIVES

The committee has made an investigation in connection with packing rings, etc., in view of the widely varying results which are reported in engines using superheated steam, and have also the privilege of presenting to the Association the results of the experiments made by the Pennsylvania Railroad on their testing plant at Altoona, on the tests of a class *K 2, s a* locomotive and on the effect of various changes in the form, length and extent of heating surface of a Schmidt superheater.

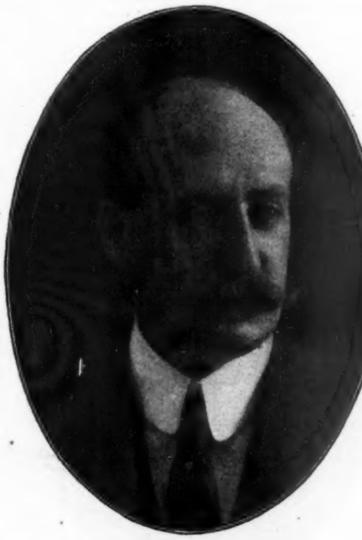
The test on a class *K 2, s a* locomotive has been printed and issued as Bulletin 18, by the Pennsylvania Railroad, and the committee recommends that it be reprinted in the Proceedings of the A. R. M. M. A., in the same way that the report on the test of a class *E 6 s* locomotive was reproduced in the 1913 Proceedings.

The tests on a Schmidt fire tube superheater showing the effect

of various changes in its form, length and extent of heating surface are presented as part of this report. This test is valuable as indicating the effect of changing the length of the superheating pipes, and the possibility of obtaining results with the return loop shortened which are equal to those with a full length return loop. The tests have been carried out in the thorough manner usual on the Pennsylvania Railroad, and this Association is indebted to their general superintendent of motive power, Mr. Wallis, for permission to present them.*

In connection with packing rings, twenty roads were written operating about 5500 superheater locomotives, and the replies may be summarized as follows:

There is a large variation in the life obtained from piston packing rings, the replies giving from two or three months or 6,000 miles, to as high as 50,000 miles or two years. Roads representing about 25 per cent. of the locomotives use a special mixture for piston packing rings, but while most of those who do so report from 50 per cent. to 100 per cent. longer service from special irons than from ordinary gray iron, the latter is used by those roads reporting the longest life in service. In several cases cylinder iron is used with 1.20 to 1.50 per cent. of silicon—the prosphorus also being kept low, not over 0.5 per cent., and with apparently good success. There is, however, considerable variation between different classes of engines, in some cases the life reported in passenger service being double that in freight, while in other cases the reverse occurs. The longest life reported is with the plain ¾-in. square ring which is used



H. H. Vaughan, Chairman, Committee on "Superheater Locomotives"

by the majority of the roads; but one road using ⅜ in. by ⅝ in. rings reports a decided improvement as against the ¾-in. wide ring, and exceedingly good results are reported by the Leighton balanced ring which is a special design and used by the Illinois Central.

The great variation in the life is peculiar, as there does not appear to be any explanation of the wide differences reported. The average life for all engines represented is five months, and this figure compares very closely with results reported by several roads that have gone into the matter carefully. It is generally suggested that ample lubrication and the use of the drifting throttle are the requirements for long life, but apart from these suggestions there is nothing to explain the variations.

The majority of the roads have used extended piston rods to some extent with improved results in most cases, especially on large cylinders, 23-in. diameter and over. Replies would indicate that if of proper design this attachment is undoubtedly an advantage, the only question being one of maintenance.

The life of piston valve rings also shows a wide variation, from as low as two months to as high as two and even three years. There is no correspondence between the life reported for piston packing rings and valve rings, in many cases roads reporting a long life for piston rings, reporting a short life for valve rings and vice versa. The average life reported is slightly over thirteen months. It is apparently but slightly affected by the material used, but several roads refer to the necessity of boring out the bushing in position to obtain good results. Very little trouble is experienced in the case of piston-valve bushings and there is evidently no serious difficulty in the maintenance of these parts.

Most roads use special types of rod packing, and with a good design there seems to be no difficulty in obtaining a life of 10,000 miles or over, with the 80 per cent. lead, 20 per cent. antimony mixture. Where this has given trouble on account of severe service and on the high-pressure cylinders of Mallet engines, a mixture of 50 per cent. copper, 50 per cent. lead has been used to advantage. One road reports improved results on Mallet engines from a mixture of 33 per cent. copper, 67 per cent. lead, but the 80-20 mixture is the one most used and is evidently satisfactory in the majority of instances.

The report is signed by: H. H. Vaughan (C. P. R.), chairman; R. W. Bell (I. C.); J. R. Gould (C. & O.); C. H. Hogan (N. Y. C. & H. R.); T. Roope (C. B. & Q.), and W. J. Tollerton (C. R. I. & P.).

Mr. Tollerton presented the report. At its conclusion he said: "The superheating question is now such a well-known one, and there are so many superheater locomotives in use, that the committee thought a discussion along the lines of maintenance of superheater equipment would probably be of more value to the members than to consider mere details in regard to construction. Therefore, it was thought desirable to bring before the Association for discussion the question of the proper maintenance of superheater equipment as it passes through the shop, the amount which it is desirable to shorten superheater tubes before they are scrapped, and the care of superheater equipment in the roundhouse.

(The report was received and opened for discussion.)

DISCUSSION

O. M. Foster (L. S. & M. S.): We use probably 30 per cent. more valve oil on our superheater engine than we used to use on the saturated steam engine, and get along as far as lubrication is concerned all right. We ran into a condition of the burning of the lubrication in the cylinder and piston valve. I suppose everyone has encountered that. We have not found out how to eliminate it. We have had the material which causes this sticking analyzed and find it is composed of cinders, valve oil, a little mud out of the boiler and a variety of things, which naturally get into the cylinder in the course of service. We thought the use of suction valves had an influence on this condition, and made some experiments, but found out that the resulting condition was about the same whether the relief valves were used or not. We bored our valve chamber bushings out every general shopping, but if they are not sufficiently worn to justify boring in the meantime, cases of cut piston valve bushings are practically unknown. We had a little trouble at first by carrying water too high in the boiler, but we got away from that. We use the Dunbar packing, a special composition of iron, and we get a variety of results, varying from the worst cases of 2,000 or 3.000 miles, up to the good cases of 40,000 or 50,000 miles for a set of packing, with an average of about 20,000 miles. I do not consider that the superheating has any particular influence on the life of cylinder packing. It depends largely on the proper fit of the piston in the cylinder. We had some engines the cylinders of which were very nicely bored out, and the piston fitted very nicely to the cylinder. They were in the heaviest kind of service, hauling iron ore and coal in trains of 100 cars generally, and when these engines had made from 30,000 to 34,000 miles, there had not been a piston renewed in any one of the twenty engines, and the cylinders and pistons were in excellent condition.

We do not have any trouble with the piston rod packing on passenger engines or on the fast freight trains, either, but we do melt out a lot of packing on slow, heavy freight trains. In order to get away from that we will have to go to a non-meltable packing. We have applied an oil cup to some of our engines by which the engineer is able to pump on to the piston rod about a tablespoonful of oil—he cannot get any more or any less than that amount—and all engineers are instructed to use that when it seems necessary. The test was made on one engine. The cup was put on one side and the other side left to be treated in the ordinary way. The result was that while one side melted out the packing practically every trip, the side equipped with the special cup did not melt out any packing at all for about six weeks. The cup was then put on the other side of the engine, with the immediate result that the good side burned out and the other side did not. If a little additional lubrication can be provided at the critical time, a soft packing may be made to work out satisfactorily. We did not find that the superheater engine needs a smaller nozzle, but

*These tests were abstracted in the *Railway Age Gazette, Mechanical Edition*, May, 1914, on page 230.

it is practicable to use one. On all of our superheater engines we are using the ordinary kind of nozzle.

L. R. Pomeroy (U. S. Light & Heating Co.): Some two or three years ago I visited various shops in the country where repairs were made to superheater engines with a view to getting some idea of safe ending the superheating tubes. At that time very few of the shops had any experience. I would like to know whether safe ending is practicable and of value in increasing the service from these engines.

W. H. Flynn (M. C.): We have been safe ending the superheater tubes and getting excellent results from them. We tried in one locality safe ending in the front end and in another on the rear end, but for economic and other reasons we decided to weld only on the front end. On one division where we have continuous, high-speed service we have been endeavoring to find something that will improve the service obtained from our cylinder packing. At the present time we are experimenting with graphite lubrication in conjunction with oil lubrication, and our results so far have been very gratifying.

Angus Sinclair: As members of this Association are liable to be looking for information in regard to the maintenance of superheater locomotives, I wish to draw their attention to a very exhaustive report made by the General Shop Foremen's Association on this subject. Mr. Pickard here is one of the leading members of that association, and no doubt he can give you some information.

F. C. Pickard: In the case of the packing rings, an average of about 900 miles on high-speed passenger engines is about what we get. Graphite cylinder lubrication is all right in a very modified form; as applied and treated in some parts of the country it is used too excessively, and its amalgamation with the valve oil chokes up the ports and gets back of the rings and plugs the valve. One particular feature that has not been given the attention it deserves, or was overlooked by a great number of us, is the changing of the injector to suit the application in the superheater engines. The average injector, which is converted, is an injector of such dimensions that it can water freely and has to be shut off, which is not conducive to good results.

In the handling of tubes, it is my opinion, and that was brought out thoroughly at the meeting of the General Foremen's Association, that the tubes could be welded practically, and there are several designs of machines which a committee is working on for that purpose at the present time.

E. R. Webb (M. C.): With superheater locomotives, and in that heavy, high-speed service, we found it was necessary to inspect the packing every thirty days, and one of the amusing things that was found was that the cylinders did not wear; the wear seemed to all come on the packing and pistons. We use a 1¼ in. packing, 15-16 or 31-32 in. wide. It was found also, in the use of the Dunbar packing, with both the square and the other section, that the wearing surfaces would be of the same dimensions. I believe that it will be found that where the packing runs ordinarily more than 15,000 or 16,000 miles the temperature of the superheater is not very good for it. As regards the cylinder lubrication, we believe it to be necessary on superheater engines.

With the graphite lubrication, we found that cracked piston-rods have practically disappeared. The examinations which the superheaters receive in the roundhouse are what determine whether they shall be successful or not. It has been found that it is quite necessary to keep the flues open to inspect the front ends and to keep the boiler tight. The superheater has made it possible to operate our service with a 22 in. by 26 in. engine, that otherwise could not possibly handle the business. The man who cleans the flues and the man who calks the flues—the men who take care of these things are really the important and vital fellows.

W. E. Dunham (C. & N. W.): When we first got superheaters we had a whole lot to learn, and it was demonstrated to us very clearly that it was a matter of attention and proper fitting up to begin with, especially on the cylinders and valves. Some of the cruder practices that were followed in the case of the saturated engines could not be followed with the superheater engines. We have not changed our general design at all, in regard to details, with the superheater engine. We use the same type of valve and the same type of piston which we previously had. It is a built-up piston-rod with a cast-iron ¾ in. square snap ring, and we get just as good results with that ring as we did with the saturated engine. As far as cylinder lubrication is concerned, we started out with a five-feed lubricator, with the cylinder lubricating attachments, but we have cut them all out practically, and do not see any advantage in them.

G. J. Duffy (L. E. & W.): We find with the superheating engines that the main driving boxes give out much more readily than they did before with the simple engines. The cylinder packing and cylinder piston run the same as before with the same amount of valve oil. We are welding our flues on the large end and are having no trouble whatever.

SPECIAL ALLOYS AND HEAT-TREATED STEEL

Engineers and manufacturers have quite generally accepted the term "heat-treatment," as applied to forgings, to cover two principal classes: first, forgings which are annealed, that is, heated slightly above the critical temperature, or point of recalescence, and then allowed to cool slowly; and, second, those which are quenched, that is, heated to a temperature slightly above the critical temperature, then cooled rapidly in some medium, and then reheated or tempered.

Replies to a circular of inquiry sent out by the committee were received from 37 railroads and two locomotive builders, covering an ownership of 31,000 locomotives.

Briefly, the replies indicate as follows:

Question 1.—Do you use any heat-treated carbon in your locomotive construction?

Four roads are using heat-treated carbon steel frames and steel castings.

Two roads are using heat-treated carbon steel for main and parallel rods; nine for piston rods, and twelve for axles and crank pins.

Two roads are using it for tires and wheels, compared with five, one year ago.

One road has discontinued its use altogether, on account of unsatisfactory service obtained.

The use of heat-treated carbon steel is still experimental, and does not appear to have been appreciably extended.

A. R. Ayers
Chairman, Committee on Use of Special Alloy and Heat Treated Steel in Locomotive Construction

Question 2.—Do you use any alloy steels in locomotive construction

Seventeen roads are using vanadium steel frames, showing an increase of nine over last year.

Ten roads are using chrome-vanadium steel for main and parallel rods, nine for piston rods, four for valve-motion parts, twelve for axles and crank pins, and thirteen for tires and wheels.

Many of those replying as users of alloy steels—in all cases chrome vanadium—are using it as an experiment, and not as their adopted practice.

Question 3.—Give any data you have showing length of service or additional wear obtained from heat-treated carbon steels as compared with plain carbon steels, and alloy steels as compared with plain carbon steels.

Service records and the personal observation of users of chrome-vanadium steel indicate that a considerable increase in wear is obtained as compared with plain carbon steel.

Tests show that valve motion parts of case-hardened carbon steel are much harder and wear much better than corresponding parts of quenched and tempered vanadium steel.

Other tests, which, however, are not yet concluded, between carbon steel axles and driving tires, compared with the same parts made of chrome-vanadium steel, indicate that considerable increase in wear may be expected from the vanadium steel.

The G. R. & I. reported an average increase of 40.5 per cent. in mileage of vanadium steel tires over carbon steel tires.

The Lake Shore reported an average increase of 38 per cent. in mileage of vanadium steel axles over carbon steel axles.

Question 4.—If you have had failures of heat-treated steel, either carbon steel or alloy steel, which were attributed to defects in the original material or to the character of heat-treatment, please describe them, giving as much detail as possible concerning the cause of failure.

The replies to this question indicate that the method of heat-treatment is an active cause of failure of both heat-treated carbon steel and alloy steels; that is, unless the quenching and tempering is properly done there is danger of checking and the production of cracks and unequal stresses.

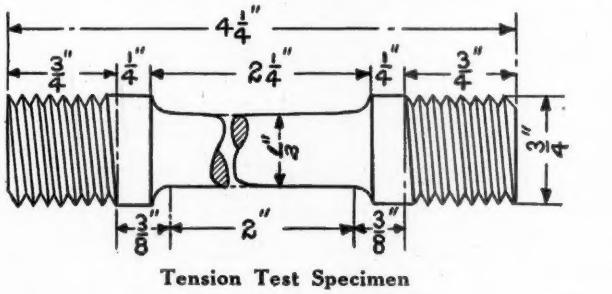
The majority of failures have been attributed to piping, segregation, impurities, and injurious effects of improper quenching.

Question 5.—If you are using in your design heat-treated carbon or alloy steels, give the unit fiber stress you are allowing for these steels in your design.

In designing locomotive parts, the general practice is to use the same working stresses for heat-treated carbon and alloy steels as for plain-carbon steel, it being considered preferable on account of lack of experience with these materials to consider their additional strength simply as a greater insurance against failure.

Question 6.—If you are using either heat-treated carbon or alloy steels, are you requiring any drilling, such as drilling through the center of an axle, in order to provide for heat-treatment or to detect defective material?

Four roads require drilling of quenched and tempered axles compared withm three that reported this requirement last year. Eight roads which did not require drilling last year reported no change in their practice this year, except one, on which drilling is now required. There are altogether six roads that are either drilling, or are contemplating drilling, which did not do this last year.



Tension Test Specimen

Question 7.—What kind of steel are you using for locomotive and tender springs?

Thirteen roads are using vanadium springs principally for test purposes. One of these roads reported that vanadium springs did not reduce the number of spring failures in spite of the fact that stronger physical properties were attributed to the steel. The remaining twenty-six roads that replied are using springs of .90 to 1.10 per cent. carbon steel.

Question 8.—What fiber stress do you use in designing springs? If you use a different fiber stress for different grades of steel, please give full details.

Vanadium springs have been designed with the fiber stress of 100,000 lb. per sq. in., which indicates to be a safe value. Carbon steel springs are usually designed with a fiber stress of 80,000 lb. per sq. in. However, the working stresses used in the design of springs appear to be more or less uniform, no allowances generally being made for the kind of steel used.

Question 9.—Are you doing any heat-treating at your own shops? If so, please describe the methods employed, the kind of steel, and the character of the parts treated.

A description of the processes employed by one railroad and one locomotive builder is contained in Appendix I.

Question 10.—In what manner, if any, do you determine whether the heat-treated axle as a whole is satisfactory for service?

Due to the lack of a generally accepted method of proof-testing quenched and tempered axles, certain individual railroads have modified the usual drop test to suit the conditions.

Conclusions.—There are to be considered in locomotive construction the following four classes of steel for forgings:

1. Unannealed plain carbon steel, of about 75,000 lb. per sq. in. ultimate tensile strength.
2. Annealed plain carbon steel, of about 80,000 lb. per sq. in. ultimate tensile strength.
3. Quenched and tempered carbon steel, of about 85,000 lb. sq. in. ultimate tensile strength.
4. Alloy steel, of about 100,000 lb. per sq. in. ultimate tensile strength.

In the case of untreated plain carbon steel and annealed plain carbon steel, the elastic limit as determined by the drop of the beam is approximately one-half of the ultimate tensile strength, while in the case of quenched and tempered carbon or alloy steel the elastic limit as determined by the drop of the beam is considrably more than one-half of the ultimate tensile strength.

No decided attempt has been made to utilize the higher physical properties of Classes 3 and 4 (quenched and tempered carbon and alloy steels) due to the lack of sufficient experience in the manufacture of these materials.

Failures attributable to the processes of manufacture may be due to the following: Material initially defective; improper heat-treatment, or a combination of both.

Defects which may remain latent in untreated or annealed material may be developed even under proper conditions of quenching and tempering to a point where they are harmful.

In cases where failures of piston rods, axles and crank pins have occurred, the fracture has usually been transverse, but there have been a few cases of longitudinal fracture.

There are three essentials to the successful quenching and tempering of steel, viz.:

1. The steel should be chemically homogeneous and free from physical defects, and its chemical composition definitely known.
2. Care must be taken that each particular piece is uniformly heated throughout.
3. Quenching should be done under conditions that will secure the uniform cooling of all pieces in each quenching charge. The proper rate of heating and cooling depends upon the size of the piece; small pieces may be rapidly heated or cooled without injury, while large pieces require a relatively slower rate of heating and cooling, to avoid excessive variations in temperature between different parts of the same forging. The medium to be used for cooling depends upon the desired rapidity of cooling. Of the three mediums previously mentioned, water is quickest and oil slowest.

Following up the recommendation of the committee of 1913, the committee submits for consideration two specifications for quenched and tempered steel forgings, one specification covering carbon steel (Appendix III), and the other specification covering alloy steel (Appendix II).

The specification for quenched and tempered carbon steel was drawn up in collaboration with a committee of the American Society for Testing Materials, and is practically the same specification that will be submitted to that society in the latter part of June, slight modifications having been made to adapt it to the requirements of locomotive construction.

The specification covering alloy steel forgings is drawn up to cover the requirements of any alloy steel, the only changes necessary being to insert a chemical composition suitable to the alloy under consideration. The specification, as submitted, covers the chemical composition of chrome-vanadium steel.

Properly manufactured and treated alloy steels of different kinds have shown that they are capable of a remarkable amount of bending and distortion without fracture of the material.

It is the belief of the committee that the manufacture of plain carbon and alloy steel to be quenched and tempered will eventually be developed to the point where such material can be used in designs involving much higher unit working stresses than are possible with untreated or annealed plain carbon steel, with a consequent reduction in the weight of parts. For this reason the committee believes that there is a wide and important field for the use of quenched and tempered carbon steel and alloy steel in locomotive construction, and wishes to emphasize the importance of making continued and extensive service tests with these materials, to encourage and assist in their development.

The report is signed by: A. R. Ayers (N. Y. C.), chairman; F. O. Bunnell (C. R. I. & P.), F. J. Cole (A. L. Co.), S. M. Vauclain (Bald. Loco. Wks.), J. C. Little (C. & N. W.), M. F. Cox (L. & N.) and C. D. Young (Penna.).

APPENDIX I.

The following are methods of heat-treating steel:

The American Locomotive Company makes carbon open-hearth and chrome-vanadium heat-treated forgings. The forgings are first annealed to refine the grain; re-heated to approximately 100 to 150 degrees centrigrade above recalescent point and quenched either in straight or soluble oil, until cooled to 300 degrees centigrade, and then re-charged into furnace (never allowed to grow cold) and heated to at least 550 degrees centigrade.

The Pennsylvania Railroad at the present time are heat-treating carbon steel driving axles, crank pins, piston rods, main and parallel rods, and springs. Axles and reciprocating parts are heated in a vertical oil-burning furnace to a temperature of about 1550 degrees Fahr., quenched in water and drawn back in a second oil-burning furnace to about 1100 degrees Fahr. The parts are not allowed to become entirely cold in the quenching

bath, but are removed while still at a temperature of about 200 to 300 degrees Fahr. Elliptic springs of 1 per cent. carbon steel are quenched in oil at about 1500 degrees Fahr., and drawn back to about 850 degrees Fahr.

APPENDIX II.

*Proposed Standard Specifications For Alloy Steel Forgings.**

These specifications are to cover the various classes of alloy steel forgings now commonly used in locomotive construction.

The purpose for which these classes are frequently used are as follows:

CLASS *A*.—Forgings for main and side rods, straps, piston rods, crank pins, and all other forgings which are to be machined with milling cutters or complicated forming tools.

CLASS *B*.—Forgings for driving and trailer axles and other parts not requiring the use of milling cutters or complicated forming tools.

Manufacture.—The steel is to be made by the open-hearth process, or by any other process approved by the purchaser.

A sufficient discard shall be made from each ingot to secure freedom from injurious piping and undue segregation.

For test purposes a prolongation shall be left on each forging, unless otherwise specified by the purchaser.

All forgings over 7 in. in diameter shall be bored, unless otherwise specified by the purchaser. The boring shall be done before heating for quenching.

If boring is specified, the diameter of the hole shall be at least 20 per cent. of the maximum outside diameter or thickness of the forging, exclusive of collars and flanges.

For quenching and tempering the forgings shall be allowed to become cold after forging. They shall then be uniformly reheated to the proper temperature to refine the grain (the group thus reheated being known as a "quenching charge"), and quenched in some medium under substantially uniform conditions for each quenching charge; forgings under Class B, over 7 in. in diameter or thickness, are to be quenched in oil. Finally they shall be uniformly reheated to the proper temperature for tempering or "drawing back" (the group thus reheated being known as a tempering charge), and allowed to cool uniformly.

Chemical Properties and Tests.—The chemical composition of the steel shall be in accordance with the alloy used, and as approved by the purchaser.

For chrome-vanadium steel, the chemical composition shall be as follows:

Carbon, .28 to .42 per cent.
Manganese, .40 to .70 per cent.
Phosphorus, maximum, .05 per cent.
Sulphur, maximum, .05 per cent.
Vanadium, not under .15 per cent.
Chromium, .75 to 1.25 per cent.

Physical properties and tests.—The forgings shall conform to the requirements as to tensile properties specified in the following table:

FOR FORGINGS WHOSE MAXIMUM OUTSIDE DIAMETER OR THICKNESS IS NOT OVER 10 INCHES WHEN SOLID

CLASS A

	Tensile Strength	Elastic Limit, Min.	Elongation in 2 in. Min.	Reduction of Area, Min.
Main and Side Rods, Straps, Piston Rods, Crank Pins.....	90 000 to 110 000	65 000	20 per cent.	50 per cent.

CLASS B

Size	Tensile Strength	Elastic Limit Min.	Elongation in 2 in. Min.	Reduction of Area Min.
Up to 7 in. diameter or thickness when solid, or 3½ in. maximum wall when bored	100 000 to 120 000	75 000	20 per cent.	50 per cent.
7 in. to 10 in. in diameter or thickness when solid, or 5 in. maximum wall when bored....	100 000 to 120 000	75 000	18 per cent.	45 per cent.

If specified by the purchaser, bend tests shall be made as follows:

For forgings up to 7 in. in diameter or thickness when solid or 3½-in. maximum wall when bored, the test specimen shall bend cold through 180 deg. on a 1-in. flat mandrel having a rounded edge of ½-in. radius without cracking on the outside of the bent portion.

For forgings 7 in. to 10 in. in diameter or thickness when solid, or 5-in. maximum wall when bored, the test specimen shall bend cold through 180 deg. around a 1½-in. flat mandrel having a rounded edge of ¾-in. radius without cracking on the outside of the bent portion.

*These specifications are materially abstracted.

Tension and bent test specimens shall be taken from a full size prolongation of any forging. Specimens may be taken from the forging itself with a hollow drill, if approved by the purchaser.

The axis of the specimen shall be located at any point midway between the center and surface of solid forgings, and at any point midway between the inner and outer surfaces of the wall of bored forgings, and shall be parallel to the axis of the forging in the direction in which the metal is most drawn out.

Tension test specimens shall be of the form and dimensions shown in Fig. 1.

Bend test specimens shall be ½-in. square in section with corners rounded to a radius not over 1-16 in., and need not exceed 6 in. in length.

APPENDIX III

*Specifications For Quenched and Tempered Carbon-Steel Forgings.**

Manufacture.—(Same as Appendix II).

Chemical properties and tests.—The steel shall conform to the following requirements as to chemical composition:

Carbon { First-class by size....0.35—0.60 per cent.
Carbon { Second-class by size..0.35—0.65 per cent.
Manganese....................0.40—0.70 per cent.
Phosphorus...................not over 0.05 per cent.
Sulphur......................not over 0.05 per cent.

Physical properties and tests.—The forgings shall conform to the minimum requirements as to tensile properties specified in the following table:

FOR FORGINGS WHOSE MAXIMUM OUTSIDE DIAMETER OR THICKNESS IS NOT OVER 10 INCHES WHEN SOLID

Size.	Tensile Strength, Pounds per Square Inch.	Elastic Limit Pounds per Square Inch	Elongation in 2 in., Per Cent.		Reduction of Area, Per Cent.	
			Inv. Ratio.	Not Under	Inv. Ratio.	Not Under
Up to 7 in. outside diameter or thickness when solid. 3½ in. max. wall when bored..............	85 000	50 000	2 000 000 / T. S.	20.5	3 800 000 / T. S.	39
7 in. to 10 in. outside diameter or thickness when solid. 5 in. max. wall when bored..............	85 000	50 000	1 900 000 / T. S.	19.5	3 600 000 / T. S.	37

If specified by the purchaser, bend tests shall be made as follows:

For the first class by size, the test specimen shall bend cold through 180 deg. around a 1-in. flat mandrel having a rounded edge of ½-in. radius, without cracking on the outside of the bent portion.

For the second class by size, the test specimen shall bend cold through 180 deg. around a 1½-in. flat mandrel having a rounded edge of ¾-in. radius, without cracking on the outside of the bent portion.

(The test specimens are obtained in same manner as in Appendix II, and are of the same dimensions.)

DISCUSSION

C. D. Young (Penn.): I move the report be received and the two specifications, shown as appendices, be referred to letter ballot for recommended practice.

(The motion was carried and the committee commended for the able work it performed.)

MINOR MECHANICAL ORGANIZATIONS

BY DR. ANGUS SINCLAIR

For many years of our railway history, two mechanical organizations, viz.: the Master Car Builders' Assoiation and our own, were considered sufficient to investigate, report on and discuss all the subjects relating to mechanical questions that required for settlement the wisdom that results from combined experience. The time, however, came by increased complication of machinery and other causes, that the Master Car Builders' and the Railway Master Mechanics' Associations were unable to cope successfully with all the engineering problems that arose for settlement, and so other organizations came into existence to aid carrying on the work that had become necessary.

The Traveling Engineers' Associations, which was formed in 1892, has certainly fulfilled the promise of its motto, "To Improve the Locomotive Engine Service of American Railroads." The rapid increase of locomotive mechanism and of operating appliances demanded the special instruction of enginemen, a duty the Traveling Engineers have performed very satisfactorily.

*Only the most important features of these specifications are here reproduced.

The practice of the Traveling Engineers' Association has been to investigate, report on and discuss subjects that would exercise an educational influence upon all persons connected with locomotive operation. In studying particulars of the twenty-one conventions held between the first one and that of last year, I find the question of how to promote economy in the use of fuel and lubricants holds a very conspicuous place. Some of the papers and discussions on these subjects are well worth earnest study by people interested in operating locomotives at the least possible expense.

About twenty-five years ago the care of air brakes became such important work that agitation arose among railway men in favor of establishing an air brake organization where men particularly familiar with air brake mechanism might meet periodically and discuss subjects of mutual interest. This culminated, in 1894, in the organization of the Air Brake Association, which has grown in numbers and influence so that its members are now considered the most influential officials regarding the operation and maintenance of air brakes. The air brake has developed slowly from the simple apparatus that used the straight air to the modern automatic brake, which does its work properly on any length of train and under the most trying conditions of speed and grades. Every advance made in train brake mechanism has been carefully studied by the Air Brake Association. The efficiency of the air brake and the extraordinary skill displayed in handling it has been due in a great measure to the intelligent labors of the Air Brake Association.

The International Railway General Foremen's Association was organized in 1905, and at once became noted for the vigorous reports and discussions they carried on concerning shop repair work and the methods of performing repairs at the lowest possible expense. From my intercourse with the proceedings of the General Foremen's Association, I am inclined to think that the individual members obtain as much valuable information by the process of exchanging notes of experience, in shape of discussion, as the master mechanics and traveling engineers do by the same process. In speaking of the work done by the general foremen at their conventions, I wish to testify to the earnestness manifested and the zealous way that the members attend the various sessions

Besides the minor mechanical associations, there are a variety of others doing good work in limited lines, all of them deserving support from the higher officials of our railroad companies. The most important of these is the Railway Fuel Association, which has 642 members. D. R. McBain, superintendent of motive power, Lake Shore & Michigan Southern, is president. The principal work carried on by the Railway Fuel Association relates to the fuel used by railway companies and methods for using the same economically. Scientific combustion and heat conserving appliances have received searching investigation from the members. Some of the best reports on the combustion of coal ever published have been prepared by members of this Association.

(The paper was received with thanks.)

SUBJECTS

The committee on subjects for the 1915 convention recommends the following subjects for the consideration of the Association:

As compared with previous reports, the number is less, with the belief that some of the subjects now under consideration. but not included in this report, may be continued.

1. Revision of standards.
2. Mechanical stokers.
3. Recommended method for uniform calculation of stresses in boilers.
4. Locomotive counterbalancing, with possible reduction in the weight of reciprocating parts.
5. Maintenance of electric equipment: Locomotives, cars and shop machinery.
6. Tender trucks: Design, and location of side bearings.
7. Alloy steels.
8. Forgings: Specifications for.
9. Plate springs: Design and heat treatment.
10. Boiler washing: Best method of caring for, at terminals.

TOPICAL DISCUSSION

11. Improvements in piston valves.
12. Cylinder lubrication with graphite.
13. Electric welding of flues.

The reasons which govern your committee in making these recommendations are:

1. Revision of Standards.

A naturally continuing subject.

2. Mechanical stokers.

Additional stokers are being continually brought forward.

3. Recommended method for uniform calculation of stresses in boilers.

There is reason to believe that not all roads are calculating the stresses on an identical basis, and consequently the figures for safety factor as reported may not be strictly comparative.

4. Locomotive counterbalancing.

This subject is recommended for further consideration, for the reason that with the increasing static weights on driving wheels, the question of dynamic augment due to counterbalancing is becoming exceedingly important, and the necessity for an improvement in the direction of a reduction of the reciprocating weights which will reduce this augment assumes at the present time an importance which it did not possess in the old days, when the principal consideration was that of securing satisfactory fore and aft balance of the locomotive.

5. Maintenance of electric equipment.

Your committee believes that the Master Mechanics' Association should keep closely in touch with the question of electric operation, with the idea that it is impossible to predict where or when electrification of steam roads may be introduced, and if this Association ignores the subject, some other association will establish standards.

6. Tender trucks.

Improvements in tender trucks are being made, and no one seems to be satisfied with conditions as they generally exist.

7. Alloy steels.

A continuation of the subject.

8. Forgings specification.

This is a subject for committee work in the American Society for Testing Materials, and your committee believes that our Association should keep in touch with the work of its sister societies.

9. Plate springs.

Your committee believes that this is still a live subject, both as to design and method of intelligent heat treatment.

10. Boiler washing.

Your committee believes that the subject of caring for boilers at terminals has so important a bearing on the question of maintenance as to justify placing it on the subject list.

TOPICAL DISCUSSION

11, Improvement in piston valves.
12. Cylinder lubrication with graphite.
13. Electric welding of flues.

These three subjects are of increasing importance in view of the general introduction of superheat.

The report is signed by:—A. W. Gibbs, (Penn.) chairman; C. E. Fuller, (U. P.) and C. F. Giles, (L. & N.).

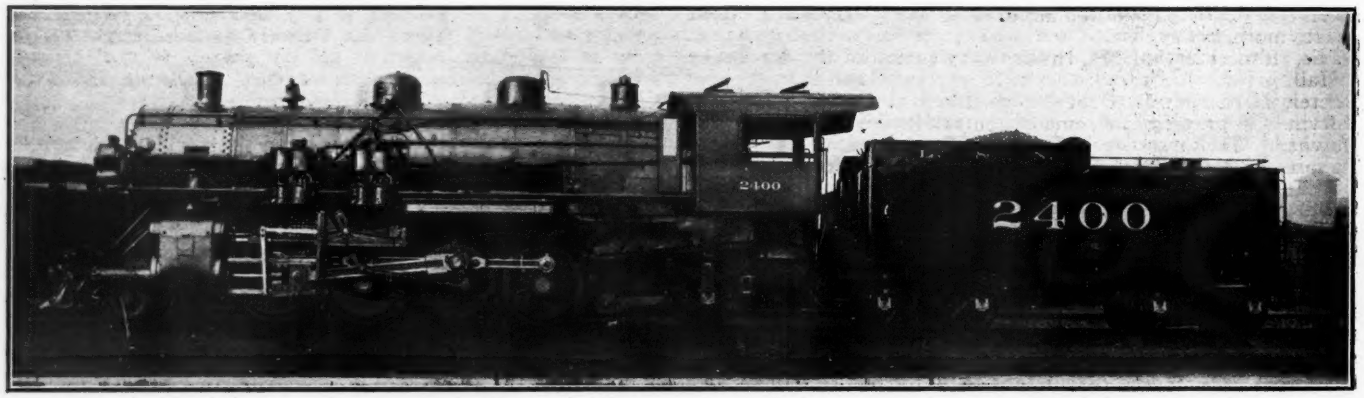
(The report was referred to the executive committee.)

NEW POWER FOR THE LOUISVILLE & NASHVILLE

The Louisville & Nashville has recently completed a new order of the Mikado and Pacific type locomotives, which were designed by the mechanical department of that road and built at the South Louisville shops. While these engines are somewhat similar in design to those built a couple of years ago by the L. & N., they are more powerful and contain improvements that have been suggested by the service of the previous engines.

The Mikado engines have a tractive effort of 57,000 lb. and weigh 290,000 lb., of which 225,000 lb. is on drivers. This gives a factor of adhesion of 3.93 and a total weight per pound of tractive effort of 5.06. The locomotives are hauling approximately 100 per cent. more tonnage than the heaviest consolidation engine operated on this road previous to 1910, and with a smaller fuel consumption. The tonnage rating on the division over which they operate is 3,500 tons. They are equipped with both the Schmidt fire-tube superheater and brick arches. The superheater has a heating surface of 922 sq. ft., which is 25 per cent. of the tube evaporating surface and 23.4 per cent. of the total evaporating surface. The grate area is 58 sq. ft., which gives a ratio of 1 to 92 with the total equivalent heating surface. The cylinders are 27 in. x 30 in. and the valves are of the built-up piston type, 14 in. in diameter. The drivers are 60 in. in diameter. The boiler is of the extended wagon top type, having a diameter of 80 in.

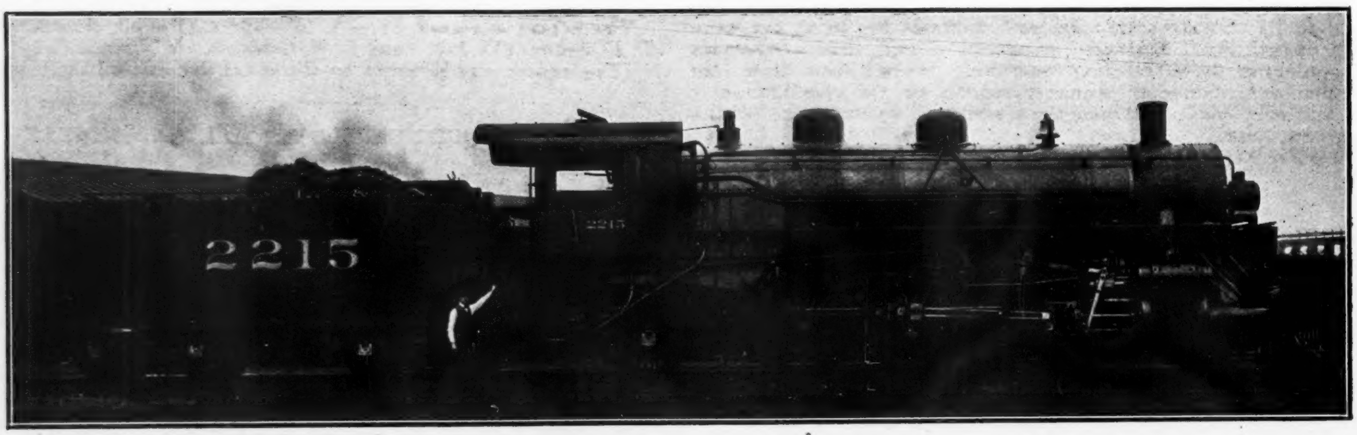
at the first course and 87 in. at the dome course. It is designed for 200 lb. boiler pressure, but only carries 185 lb. The factor of safety is 4.5. The feature of particular interest is the exceptionally deep throat sheet. The designer has succeeded in getting a depth of throat sheet of 30½ in., which provides a clear distance of 24 in. between the arch-tubes and the grates. Adjustable staybolts (Cox Patent) are used in the breaking zone of the firebox, and the crown sheet is supported by radial stays. The Cox throttle valve is also used, this being standard for the Louisville & Nashville. The special feature of this valve is that it allows inspectors to pass through the dome into the boiler without obstruction.



Heavy Mikado Locomotive Designed and Built by the Louisville & Nashville

Among other features of this engine are: Outside bearing trailer trucks, with 58-in. springs; bushed cylinders and valve chests, heavy crosshead gibs that may be removed from the outside; encased piston rod extension; all-steel pilot; pneumatic fire door; steel cab; reach rod guide, which reduce the vibration of the valve gear; cast-steel 6-in. frames, and flange lubricators.

The Pacific type engines have a tractive effort of 31,720 lb., which, with a weight of 139,800 lb., gives a factor of adhesion of 4.34. The total weight of the engine is 228,300 lb., or 7.2 lb. per pound of tractive effort. They are also equipped with Schmidt superheaters and brick arches and have a superheating surface of 356 sq. ft., which is 16.1 per cent of the tube evaporating surface. The grate area is 45 sq. ft and its ratio to the total equivalent heating surface of 2,979 sq. ft. is 1 to 66.2. The cylinders are 22 in. x 28 in. and the valves are of the piston type and are 12 in. in diameter. The driving wheels are 69 in. in diameter, which is somewhat smaller than many other roads are using on this type of engine. It was believed, however, to be more practical than the 72-in. driver.



Pacific Type Locomotive Designed and Built by the Louisville & Nashville That Has Been Giving Particularly Good Service

The boilers of these engines are of the straight top, with radial stays and the adjustable staybolts in the breaking zone. The diameter of the first course is 71 in. The boiler is designed for a pressure of 200 lb., but is operated under a working pressure of 190 lb. Its factor of safety is 4½. The engines have the same depth of throat sheet as the Mikado locomotives and are also provided with same type of throttle.

The principal differences between these locomotives and those built some two years ago are the increase in cylinder diameter from 21 in. to 22 in., the use of the outside on bearing trailer truck, an increase of 8 in. in the wheel base, increase in the length of boiler tubes from 18 ft. 6 in. to 20 in., the use of the pedestal type equalized tender truck, and the cast steel pilot. These two types of locomotives are giving splendid results.

ADDITIONAL MASTER MECHANICS' REGISTRATION

Booth, J. K., Gen. Foreman, B. & L. E., Traymore.
Cole, H. L., A. S. Locomotive Supt., Indian Govt. Ry. Board.
Delaney, C. A., American Loco. Co., Traymore.
Gormley, Joseph, Asst. Train Master, Penna., Jackson.
Gross, E. G., M. M., Central of Ga., Haddon Hall.
Hill, J. F., M. M., W. & L. E.
Hogan, C. H., S. M. P., N. Y. C. & H. R., Marlborough-Blenheim.
Kneass, S. L., Wm. Sellers Co., Ltd., Chalfonte.
Kothe, C. A., M. M., Erie, Chalfonte.
Lovell, F. A., M. M., Spanish-American Iron Co., Shelburne.
Parks, G. E., Asst. Engineer, N. Y. C. Lines, Marlborough-Blenheim.
Quercan, C. H., Supt. Elec. Equipment, N. Y. C. & H. R., Traymore.
Reagan, Frank H., S. S., D., L. & W., Traymore.

Smith, H. E., Chemist, L. L. & M. L.
Wood, A. J., Assn. Prof. R. R. M. E., Penna. State College, Arlington.

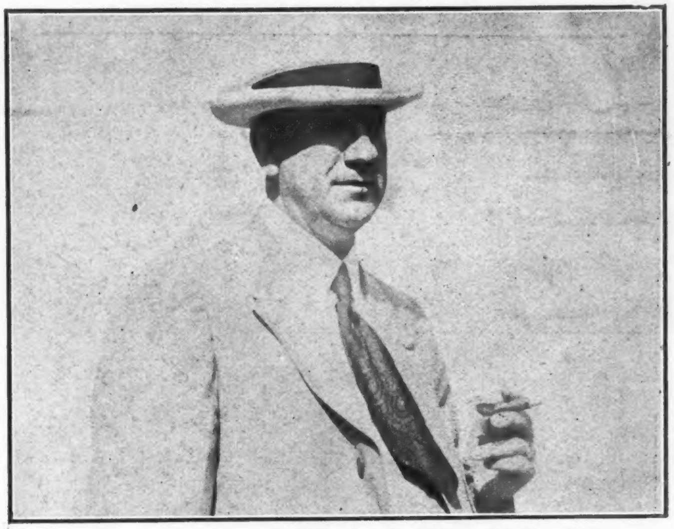
ADDITIONAL REGISTRATION OF SPECIAL GUESTS

Barbey, George D., Eng. Ex. Division, Chester Inn.
Bartholomew, W. E., Shop Inspector, Penna., Elberon.
Beall, Evard, B. & O., Channell.
Beall, J. W., Insp. Motive Power Dept., B. & O., Channell.
Beatty, Wm., Purchasing Dept., Penna.
Boice, C. D., Purchasing Agent, Florida East Coast.
Carter, G. H., T. E. H., P. & R.
Davis, B. H., Road Foreman of Engineers, D., L. & W., Traymore.
Davis, Robert L., M. P. Inspector, Penna. R. R., Haddon Hall.
Deeter, H. E., M. P. Dept., P. & R.
Dervin, F., Traveling Fireman, Central R. R. of N. J.
Downs, J. H., Asst. Road Foreman Engines, Penna.
Dugan, G. A., Genl. Foreman, Reading.
Dupell, R. E., Rd. Foreman of Engineers, Penna.
Eyde, E. C., Chief Train Despatcher, Penna.
Gillis, A., Foreman, B. & O., Channel.
Goritz, John, Foreman Machine Shop, Penna., Traymore.
Haenchen, J. P., F. E. H., P. & R.
Haig, J. Frank, P. A., B. & S. P.
Hayes, H. B., M. M., C. M. O. & T. P., 118 Illinois Ave.
Heinbach, W. F., Round House Foreman, Phila. & Reading, Larchmont.
Henratty, Edward, Veteran Engineer, P. & R.
Henthorn, J. T., Insp. Test Dept., B. & O., Absecon.
Higgs, G., Traveling Fireman, Central R. R. of N. J.
Hoffmann, N. K., Supt. Car Service, P. & L., Martin.
Hollett, G. T., Stat. Eng., B. & O., Worthington.
Jenkins, Walter, Engineer, W. J. & Seashore.
Jones, S. L., Road Foreman Engineer, W. J. & S. S.
Jost, J. William, Draftsman, P. & R.
Kavanaugh, R. D., Insp. Test Dept., Penna., Haddon Hall.
King, W. A., Chief Engineer, Washington Terminal Co., Arlington.
Lougenecker, F. R., Asst. Trainmaster, Penna.
Ludlam, George, Engineer, West Jersey & Seashore.
Lynam, C. J., Inspt. M. P. Dept., B. & O., Channell.
Maginn, J. J., Genl. Foreman, Cin. Northern, Shelburne.
Michael, H. C., Secy. Eng. of Tests, B. & O., Absecon.
Minnett, Harry, Foreman, W. J. & Seashore.
Neale, F. A., G. Foreman, C. R. R. N. J., Marlborough-Blenheim.
Newbery, T. E., Test Dept., Penna., Haddon Hall.
Nicholas, R. H., General Foreman, C. R. R. of N. J., Lyric.
Pack, A. A., Washington Terminal.
Powell, J. H., R. F. E., N. Y. P. & N., Sterling.
Ranck, E. B., M. M., Penna., De Villa.
Reyno, E. R., S. Keeper, Penna.
Roberts, George H., General Foreman, Lehigh Valley, Edison.
Robinson, W. L., Supervisor Fuel Consumption, B. & O., Haddon Hall.
Roche, John J., Foreman Blacksmith, P. & R.
Rosenberg, Charles R., Passenger Solicitor, Penna.
Rossiter, C. A., Washington Terminal.
Schenck, Edwin, Jr., Asst. M. M., Penna.
Scott, Harry C., General Machine Foreman, Phila. & Reading, Braidwood.
Seiders, J. L., Foreman Blacksmith, P. & R., Albermarle.
Shipley, W. H., Foreman Blacksmith, W. M., 103 Maryland Ave.
Sinclair, I. B., Inspector Asst. Gen. Mgr., Penna., Chalfonte.
Smith, J. A. B., Rear Admiral U. S. Navy, 106 Vermont Ave.
Smith, W. M., Engine House Foreman, Reading, Whittle.
Stahlberger, Philip, Road Foreman of Engines Atlantic City Railroad.
Stull, H. W., Foreman Machine Shops, P. & R.
Tarcelan, H. I., Asst. Eng. of Tests, B. & O., Chalfonte.
Taylor, Jas. M., Foreman Round House, P. & R., MacDonald.
Trego, J. G., Asst. Rd. Foreman, Penna.
Watkins, G. H., Asst. M. M., Penna., Dunlop.
Watt, C. N., Road Foreman, Penna.
Wilson, Frank G., Gen. Upholsterer, Reading, Brevort.
Wilson, J. M., Foreman Engine Houses, Central R. R. of N. J., Albourne.
Wise, H. E., Lumber Inspt., Penna.
Yost, G. K., Asst. Chief Draftsman, B. & O.
Zelley, Walter G., General Foreman Car Inspt., West Jersey & S. S.

Conventionalities

In the Chicago & North Western Club picture in the *Daily* of June 16, the Edward Williams credited to the Pittsburgh Steel Foundry Company should be Edward J. Williams, of McCord & Company.

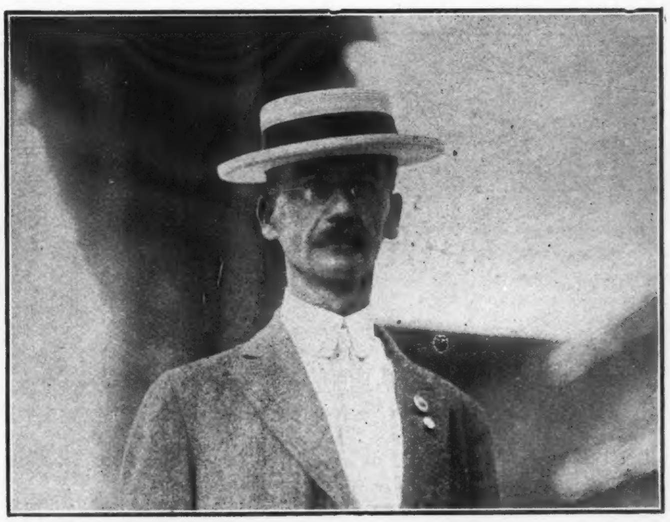
John J. Wirth who is attending the conventions has made arrangements to represent the Garlock Packing Company,



G. E. Carson, Master Car Builder of the New York Central at West Albany

and leaves for Colon, Panama, on June 20th. From Panama he will visit various cities in South America and Cuba.

H. E. Hunt, of the Electric Storage Battery Company, is rejoicing because of the receipt of an order from the Southern Pacific for 650 sets of Ironclad Exide batteries for use in elec-



W. O. Moody, Mechanical Engineer of the Illinois Central

tric headlights, making a total of 946 sets ordered by that road.

Carl Smith, mechanical engineer of the Boston & Maine, has not yet turned up this year, and there is some question as to whether he will come to the convention. During the past year he was president of the New England Railroad Club and had a most successful administration.

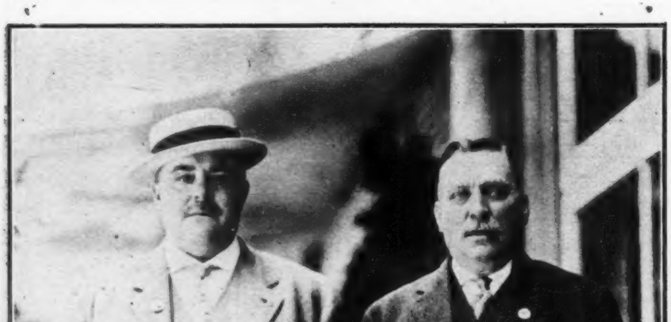
We deplore the absence of George N. Van Sweringen, of the Chicago Railway Equipment Company. Business is said to have kept him in Chicago, but he was last seen under his new car—fighting with the machinery. George is said to sing "Get out and Get Under" with great emotion.

Willard Doud, special engineer of shop construction, Belt Railway of Chicago, reports that the work on Clearing shops at Chicago is progressing finely. These shops will handle 95 locomotives and will repair all cars passing through the new clearing classification yards. The shops will be completed about September 1.

The position of superintendent of apprentices on the New

Left to Right—H. M. Belnap, Chief Inspector Safety Appliances, and F. McManamy, Chief Inspector Interstate Commerce Commission

York Central Lines has been abolished and the apprenticeship training will in future be conducted under the supervision of each superintendent of motive power. C. W. Cross, who has held the position of superintendent of apprentices since the



Left to Right: Wm. Owens, New York Air Brake Co., and J. L. Smith, M. M., Pittsburgh, Shawmut & Northern

inauguration of the work in 1906, will engage in other business.

Understating, rather than overstating the merits of a device is usually good policy, especially where you have the actual means of demonstrating the actual output—at least this is the policy of John Mahin of the Warner & Swasey Company. For example, a sign on their table reads, "Knuckle Pins in 7½—8 minutes." They are actually producing this work at the remarkable rate of 4 minutes.

They said it was a polo game on the beach opposite the Shelburne Monday afternoon, but the audience seemed to be in

R. B. Stout, Mechanical Efficiency Expert, Southern Pacific

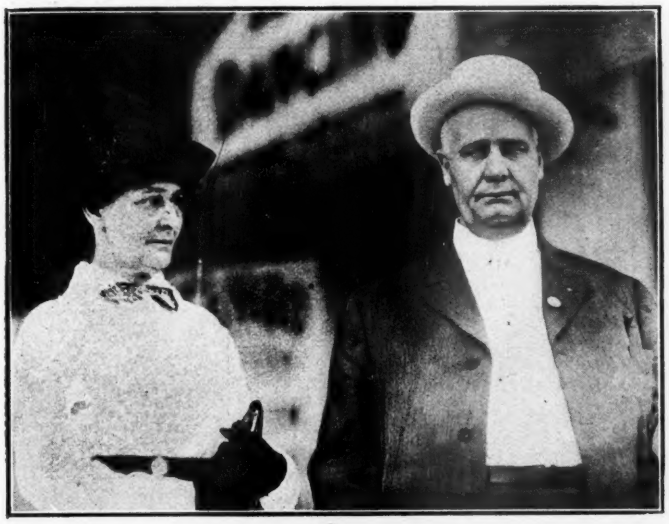
doubt as to just what appellation to give it. Most of the eight players, four on each side, composed of supply men, experienced much more difficulty in maintaining their mounts than in hitting the ball. For some time the "contest" was bitterly staged, and at its conclusion it was stated that the Gringoes had defeated the Mexicanos. No one could dispute the decision.

G. S. Edmonds, superintendent of the Delaware & Hudson

The Long and Short of the Convention
The Big One, L. L. Yates, Supt. Car Dept., Pac. Fruit Exp.
The Little Chap, W. H. Emerick, Genl. Trav. Inspector of the Same Company

shops at Watervliet, N. Y., came in on Monday. One of the peculiarities of these shops is that the blacksmith shop and the erecting shop are under one roof; a system of ventilating has been installed which eliminates trouble from gas accumulating in the building. The steel foundry, in which the Delaware & Hudson makes practically all of its own steel castings, is also located at Watervliet and is under Mr. Edmonds' direction.

F. J. Harrison, superintendent of motive power of the Buffalo, Rochester & Pittsburgh, who is attending the convention, is quite enthusiastic over the new engine house which has just been placed in operation at Du Bois, Pa. One of the most important features of the new house is a circular traveling crane, the runway of which extends over



W. O. Thompson, the Dad of the Traveling Engineers' Association, and Mrs. Thompson

all of the pits in the house. This requires a c considerable amount of head room, but provides splendid lighting. The house was opened up a short time ago.

H. Osborne, assistant mechanical superintendent of the Canadian Pacific, takes a keen interest in the machine tool exhibit. Mr. Osborne has always been largely a shop man. He was in charge of the locomotive repair work at the

Mr. and Mrs. W. E. Dunham (Master Mechanic, D. L. & W.) and Their Three-Year-Old Son, Who Is Attending His First Convention

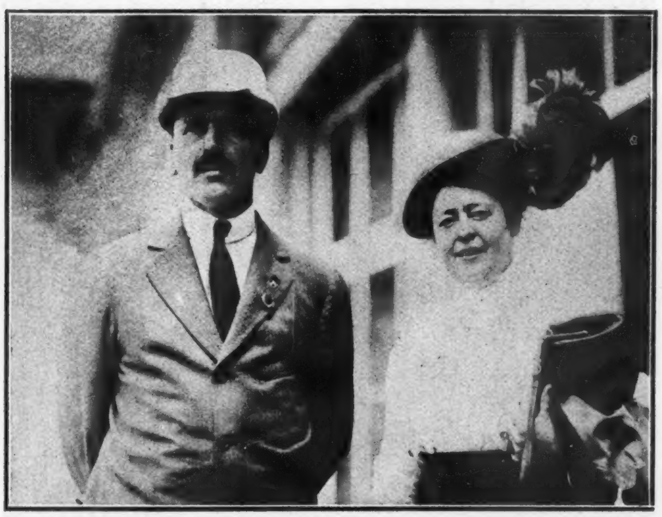
Delorimier Avenue shops of the Canadian Pacific at Montreal before the Angus shops were built and was afterwards superintendent of the locomotive shops there. He was assistant superintendent of motive power at Montreal up to the past winter when he was appointed assistant mechanical superintendent.

At a social gathering of a small portion of the happy "G. E." family held the other evening, some very clever talent was developed. Several of the party proved that while they may be stationed at far off points, they have not neglected keeping up to date with the many new tango steps. Mr. "Ian" McLaren made a big hit with several of his clever specialties, such as original "G. E." songs and particularly his "best man" variety. With the latter he has quite a reputation, and his presence always insures pleasant and original entertainment.

H. L. Delo, formerly assistant chief motive power clerk of the Pennsylvania Lines East, entered the service of that

Frank H. Cunningham, Until a Few Days Ago Inspector of Stokers for the N. & W.; Now with the Standard Stoker

company on April 1, 1854. He has been retired eight years. During his service his name was never off the roll for a day. Mr. Delo is living at Altoona and is still hale and hearty. He doesn't look to be more than sixty years of age. This is remarkable after a service of 52 years and three months. He will be 78 years of age this month. He has three boys in the service now. O. F. is chief clerk to the superintendent of the Middle Division; George H.



Robert Blake, Master Mechanic of the N. P., and Mrs. Blake

is car shop clerk at Altoona; H. E. is chief electrician of the Eastern Grand Division.

There was a happy reunion at the Chalfonte Sunday evening, between three old-time friends. Some 30 years or more ago there were working in the Baltimore & Ohio shops at Grafton,

West Virginia, three young men who formed a strong friendship for each other. Their problems in life were mutual and each was a help to the other in climbing life's ladder. In the course of time these three men drifted apart in various sections of the country and for a considerable period of time saw little of each other. The M. C. B. and M. M. Conventions

Joseph Washington, Colored, Aged 9 Years—The "Major Domo" in Charge of the Exhibit of the American Steel Foundries

brought them together at Atlantic City, and Sunday evening an old-time experience meeting was held at the Chalfonte. It is needless to say that the evening was greatly enjoyed. The

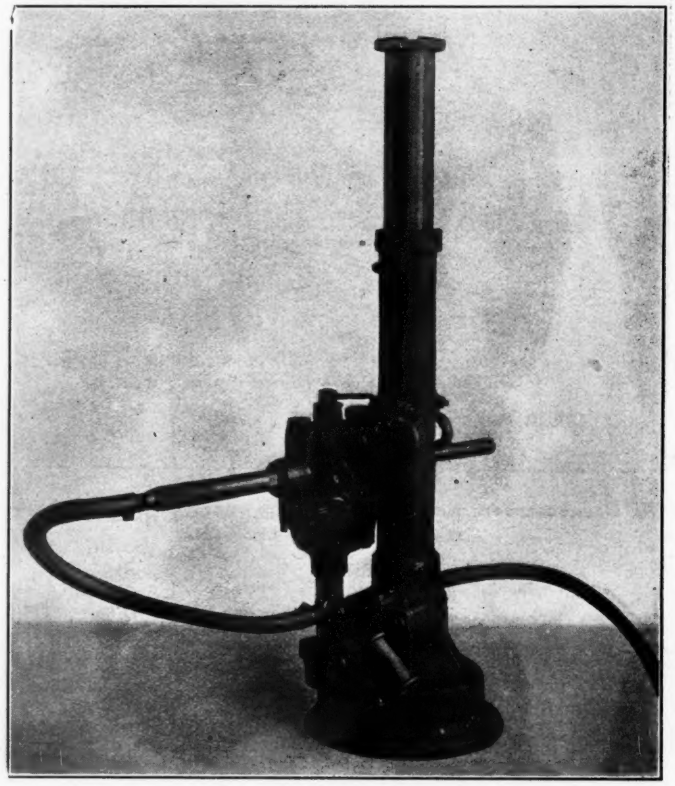
George Bourne's Son Billy Riding the Goat—His Father's Favorite Job

men were C. F. Giles, superintendent of motive power of the Louisville & Nashville, M. J. Drury, superintendent of shops of the Santa Fe, and John Moran, of the Bethlehem Steel Company.

MOTOR DRIVEN SCREW JACK

A high speed motor driven ball bearing screw jack is on exhibit at the booth of the Cayuta Manufacturing Company. As shown in the illustration this jack is designed to be driven by any standard make of portable electric or air motor, with No. 3 or No. 4 Morse taper or square socket.

The motor driven speeds range from 6 in. to 12 in. per minute.



Motor Driven Ball Bearing Screw Jack

Under a recent test these jacks are reported to have raised one end of a dining car weighing 140,000 lb. 11 in high in one minute. An automatic device is provided which controls the rise, stopping the load at any desired point. The jacks are arranged for hand operation, if for any reason this may be desirable.

SUPPLEMENTARY EXHIBIT LIST

The following firms have joined those making exhibits on the Pier since the opening of the conventions, at which time we published the complete list:

Baucher, T. D., Reading, Pa. The Marvel kindler and fuel. Represented by T. D. Bausher. Space 363.

Frictionless Rail, The, Boston, Mass. Samples of the frictionless rail. Represented by F. A. Barbey, S. A. Simonds, J. W. McManama and Geo. F. Bryant. Space 201.

Panama-Pacific International Exposition, San Francisco, Cal. Pictures and literature regarding exhibition in 1915. Represented by W. T. Sweet. Space 366.

Quincy & Manchester Company, Chicago, Ill. Edman box and refrigerator car door. Represented by C. F. Quincy, Percival Manchester, E. R. Packer and W. W. Hoit. Space 185.

Universal Car Seal & Appliance Company, Albany, N. Y. Universal car door fasteners. Represented by W. C. Martineau. Space 362.

Withrow, P. C., Denver, Colo. Gravity fire door. Represented by P. C. Withrow. Space 363.

AIR PUMP PISTON SWAB

The illustration shows a reversible piston swab which is being exhibited by the Ashton Valve Company. It is especially adapted for use on air pump pistons and may be very readily applied or removed.

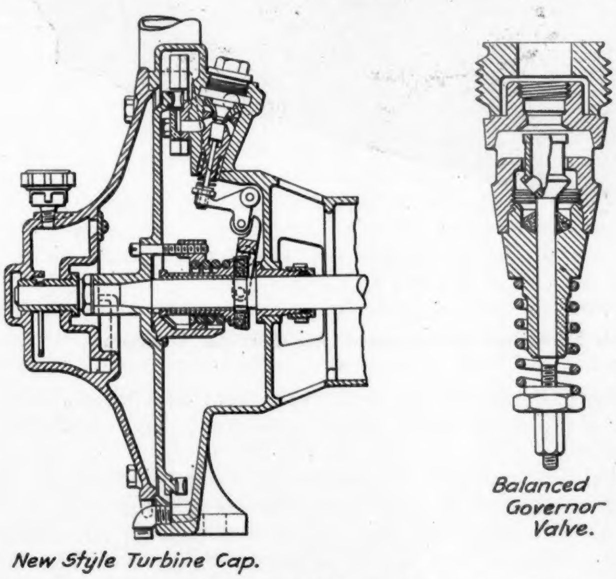
The body is made in two pieces which are hinged together and are held closed by a steel spring. An oil chamber with a

Ashton Air Pump Piston Swab

projecting lip is provided in each section of the swab body. These are on opposite faces, thus making it reversible. By filling the space between the two gland nuts the swab also serves as a lock, preventing the nuts from working loose.

ELECTRIC HEADLIGHT EQUIPMENT

A number of improvements in its equipment are being exhibited this year by the Pyle-National Electric Headlight Company, Chicago. An improved design of turbine cap, a section of which is shown in one of the illustrations, has been introduced during the year. The advantage of the improved cap lies in the arrangement of an overflow port which relieves the water of

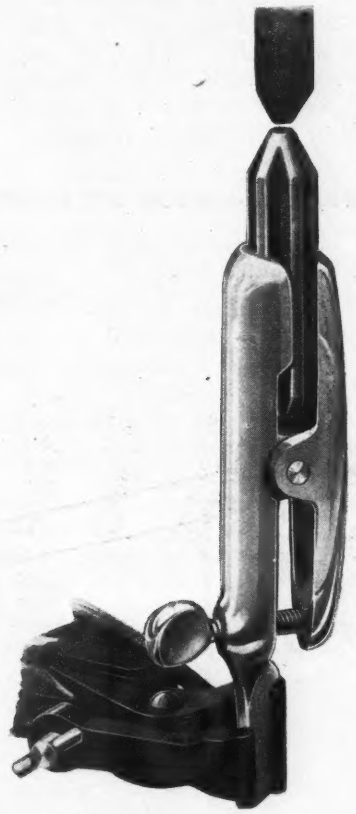


New Style Turbine Cap and Balanced Governor Valve for Type E Equipment

condensation as it accumulates, without any effect whatsoever on the oil level maintained in the oil chamber. This cap replaces the one originally applied to the type E equipment.

An improved governor valve, a section of which is illustrated, has also been designed for the type E equipment. This valve is balanced so that there is no effort exerted from the admission side of the governor valve to counteract the action of the governor weight. This greatly reduces the friction and consequent wear of the operating parts of the governor and overcomes the necessity of making special adjustment of the governor weight tension screw when generators are changed from low to high pressure locomotives, or vice versa.

An improved type of lower electrode is also illustrated. It will be observed that the electrode is fluted, thus reducing the section and exposing an increased amount of surface to the



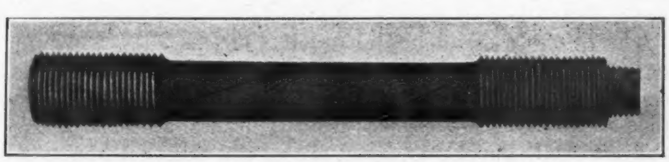
Fluted Lower Electrode

cooling action of the atmosphere. It is stated that this type of electrode will sustain six volts greater potential before fusing than the solid electrode formerly used.

A special headlight case is being exhibited this year. This is built with a door that extends to the top of the canopy so that the reflector and slide can be removed without the necessity of removing the carbon holder.

AMERICAN STAYBOLT

Improvements have been made in a number of features of the "American" staybolt, which was exhibited for the first time last year by the American Flexible Bolt Company of Pittsburgh. In this new design the body of the bolt, composed of two



American Flexible Staybolt with Solid Ends

separate half-round sections spirally arranged as in the original design, is retained, because this structure obtains maximum flexibility.

The improvements, it is claimed, give this type of staybolt the following additional advantages: The threaded ends are now solid—not welded as in the original design—and may be of any

lengths desired. The outer end is champfered and the inner end is provided with a square, both to facilitate application. The tell-tale hole is applied in the outer end, as this type of staybolt, on account of its responding to the regular hammer test, and because of its appearance after being applied, comes within the Interstate Commerce Commission inspection requirements for the ordinary rigid staybolt; the tell-tale hole is now drilled centrally to the required depth and is countersunk to eliminate drifting after heading over.

Aside from the economy of application of this staybolt because of its solid ends threaded into the sheets of the firebox, it is claimed that the flexibility of body not only provides maxinum life of the staybolt itself, but also operates to increase the life of the inner sheet of the firebox by relieving the stresses in the latter that occur in daily service conditions.

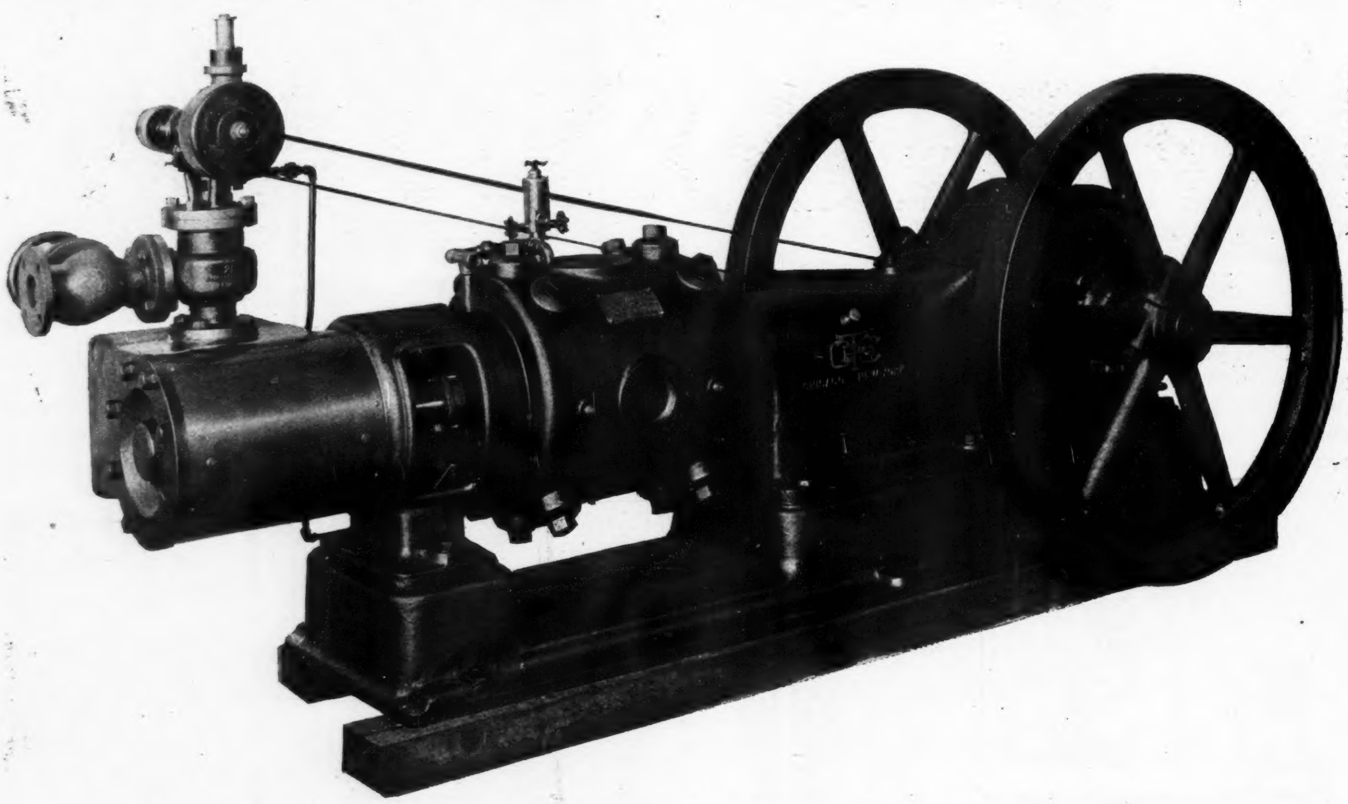
COMPRESSED AIR FOR THE EXHIBITS

A design of air compressor which has recently been developed is installed in the booth of the Chicago Pneumatic Tool Company, where it is in operation, furnishing the compressed air supply for the convention exhibits. This type of compressor is built for direct steam, fuel oil or belt drive. The illustration shows the steam driven machine.

The frame is completely enclosed, and removable oil tight covers for the side and crank case give ready access for inspection of parts and necessary adjustments. Main bearings are of large proportions, are cast integral with the frame and are well supported. They are of the diagonal box type lined with babbitt metal and provided with grooves for the conveyance of oil. A means of adjustment if the bearing caps is provided to compensate for wear. Oil lips are cast on the frame and caps and serve to catch and return to the interior of the frame any oil leaking through the bearings.

The air cylinder is designed to permit of reboring with safety, and together with the heads is completely water jacketed. The piston is provided with two cast iron spring rings. The valves are vital points in an air compressor and are worthy of careful attention in designing a compressor to operate at the speeds demanded by present practice. The results of years of practical experience and prolonged tests under severe conditions are reflected in the flat disc type of inlet and discharge valves incorporated in this machine. They are set radially in the cylinder, and are arranged to give a minimum clearance and afford a higher volumetric efficiency than is usually obtainable with small compressors. No cages are employed and the openings for air are consequently relatively large and direct. This feature eliminates the necessity of lubrication and assures a minimum power consumption to discharge air from the cylinder. Designed for high speeds, the valves are made very light. To secure the required strength specially selected materials are used, and the lift is reduced to a minimum.

The crank shaft is of the center crank type, made of open hearth forged steel and of liberal proportions throughout. Adequate counterbalance weights are provided to insure steady operation of the compressor at high speeds. The connecting rods are made from steel forgings. The wrist pin end is of the solid type, fitted with bronze boxes, while the crank end is of the marine type lined with babbitt metal.



Class N.S.S. Chicago Pneumatic Air Compressor Which Furnishes Compressed Air for the Exhibits

Friction and wear are reduced to a minimum and heating and cutting of bearings prevented through the medium of a splash system of lubrication, which delivers oil through distributors to the various bearings. Both steam and belt driven machines of this type are equipped with a simple unloading mechanism by means of which the air inlet valves are held from their seats when the desired receiver pressure is obtained. This relieves the compressor of all load and proportions power consumption to air capacity requirements.

Steam compressors are provided with a combined speed governor and air pressure regulator of approved design, this automatically controlling the speed of the machine in accordance with the demand for air.

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WE GUARANTEE, that of this issue more than 8,100 copies were printed; that of those more than 8,100 copies 7,535 were mailed to regular paid subscribers to the Railway Age Gazette, weekly edition and Railway Age Gazette, Mechanical Edition; 224 were provided for counter and news companies' sales; 241 were mailed to advertisers and correspondents; and 100 were provided for distribution at Atlantic City.

Committee Reports Illustrations

The illustrations in both the reports of the Master Car Builders' and the Master Mechanics' Associations form a vital part of the work of the committees. It would seem, therefore, that more care should be taken to obtain illustrations that are more eligible, to say nothing of making them look like real drawings. There are several instances this year where some important drawings are made valueless on account of their imperfect reproduction. Better cuts may be obtained in two ways—by redrawing the very large drawings and strengthening the lines so that when the size of the drawing is reduced on the cut the lines will be heavy enough to clearly show the necessary detail; or by submitting small neat drawings, not blue prints, that do not require much reduction. The latter method would be, by far, the more economical, and if the different committees were required to adhere to some definite standard in this respect very much better results would be obtained. It is a matter that may very easily be corrected and the results would be greatly appreciated by all of the members of the association and readers of the proceedings. In view of the high standing and importance of both the M. C. B. and M. M. Associations and the large amount of time and money spent in gathering together the valuable information contained in the reports it is too bad that they can not be presented in better shape.

The Prevention of Smoke

The position taken by E. W. Pratt, chairman of the committee on Smoke Prevention, that members of the Association should make use of devices that have proved themselves, is a good one. The experiments with steam jets for eliminating smoke, which were carried on by this committee, and the results that have been obtained in service, have showed conclusively that their proper installation and use will prevent smoke. The committee has done a great deal of hard work and the railways should avail themselves of its results. The matter of smoke elimination is not by any means settled. The idea is being taken up by city after city; it may be expected that the agitation against smoke will not only continue but will increase, and it will be to the railways' credit if they take the steps necessary to smoke prevention of their own accord. There is work of perfecting to be done in connection with the steam jet method. D. F. Crawford referred to steps that are being taken on the Pennsylvania Lines to do away with the noise of the jets, and several members spoke of the necessity of care on the part of the engine crew, but there is no question that the use of the arrangement of jets recommended by the committee will go a long way toward eliminating smoke in locomotive service.

Consideration of Fuel Economy Continued

The plain, bare statement that the talk about fuel economy, due to reduction of scale, was mostly talk, would probably have greatly astonished the men who have considered the subject from a theoretical standpoint only. Of course, scale is a non-conductor, and retards the transference of heat to the water, but there are so many variables connected with steam production on a locomotive, that the differences in fuel consumption between a boiler with scale and one that is clean is inappreciable. This does not mean, however, and the makers of the statement did not intend it to mean, that scale preventatives were not desirable. Merely that the value of minute refinements were overestimated. The manner in which coal is bought by railroads, dependent as it is on the location of the mines and the length of haul required to deliver it to the coaling stations, makes the purchase on the thermal value plan impracticable. Further than this, Mr. Crawford's point that it would be advisable to force the matter to the exclusion of the poorer coals, because of the resulting rapid exhaustion of the good coals, seems to be a point well taken. And further, because a variation in the thermal values of coal does not, necessarily, result in a corresponding variation in consumption per unit of work done. In short, the brief discussion on fuel economy may be summed up in the fact that the association considered the subject too large to be disposed of by one report of a committee, or of a limited number of succeeding committees, and so decided that it had best be handled by a standing committee.

The Tonnage Rating Discussion

The discussion on tonnage rating swung about the desirability for simplicity of method in making up trains. With some fifty odd resistance formulæ available, running the whole gamut of complexity and simplicity, it is small wonder that there is confusion in the minds of some operating officers as to the best method to use. The formulæ result, of course, from the differing conditions obtaining in the tests from which they were derived. Indeed, it would be difficult to imagine a case where variables were more rampant than they are in the hauling conditions of a train over a division. No two divisions, trains, pieces of track, days' temperatures or wind directions and intensities are alike, so that the wonder is that even a workable or acceptable average can be obtained. Therefore, each road and division must

be a law unto itself to a certain extent, and be worked to the best that its local conditions permit. And, even after a method of calculating tonnage rating has been adopted, it must be subjected to constant supervision. The temptation to underload, on the part of yard clerks, for the purpose of easing the work of the men and getting trains over the road is great and must be watched. In like manner a weather eye, from above, may well be kept on some young superintendents who are anxious for a record, and are inclined to yield to the temptation of overloading for the sake of making a record. Unfortunately, that record too often is one of stalled and delayed trains. This matter has been before the association for many years, and it will probably still remain there for a number of years to come, so that its reference back to the committee for further consideration is a wise measure, and it is probable that there will be many such references back before the question will be finally disposed of.

A GRATIFYING RECORD

NOW that the conventions have closed, it is possible to stand off and get some idea of the effect of the meetings and of the exhibits as a whole. In the first place, the number of the members of the two associations who attended the conventions was larger than for the past two years, and practically the same as for the record year 1911. The registration of special guests, ladies and supply men showed a considerable falling off, although there was very little difference in the number of exhibitors this year as compared with 1913. The reports presented at both of the conventions have been exceptionally thorough and complete, although possibly the M. C. B. Association made a slightly better showing in this respect. The discussions in both associations have been particularly good and the number of the younger men who took part in them is especially noteworthy. The younger men are being encouraged in this, and it is hoped that they will feel free to enter the discussions even more fully next year. In spite of the severe limitations of the convention hall, the meetings have proved most effective and the officers of the two associations and the committees which prepared the reports and papers are to be congratulated.

As indicated in President Hegeman's report before the Railway Supply Manufacturers' Association on Saturday, the actual number of square feet of space utilized by the exhibitors this year is slightly smaller than that of last year, but never have the booths been arranged so attractively and so much intelligent effort been put into making the exhibits an educational feature. A canvas of a large number of the exhibitors yesterday morning indicated without exception that they were all very much pleased with the attention that had been given to their displays, and were more or less enthusiastic in making the preliminary plans for their exhibits next year. The exhibit committee may justly be proud of the splendid showing which was made in Machinery Hall this year. It is interesting to note that five of the machine tool manufacturers who did not exhibit, but who attended the conventions, have already made application for space next year. Several of the other exhibitors throughout the pier, who occupied relatively small spaces, have made application for larger spaces in 1915 in order that they may display their products to even better advantage.

The impression that one got in looking over the exhibition was that there was less fuss and furore than has been noticeable in previous years. There seemed to be a very strong tendency toward a quiet, intelligent investigation into the various products which were displayed. The fact that the number of supply representatives was smaller this year per exhibit, and that there were more railroad men than in 1912 and 1913, may possibly have some bearing on this; at least this is the explanation that was advanced in one or two cases. That it is really not the greatest reason is indicated by the fact that several of the roads apparently made special assignments to their representatives this year to look into and investigate certain specific things which they were asked to report upon with a view to influencing the purchase of such materials. In one case a meeting was held a couple of months ago, and it was decided just what features it would be best to investigate and follow up in connection with the June exhibit.

It is needless to repeat here the fact that the most progressive and thoughtful of the railroad men examine the exhibits carefully to see what developments have been made during the year, and that they regard this as just as important a part of attendance at the conventions as they do taking part in the technical discussions. It may, however, be interesting to cite two or three expressions which were heard from different exhibitors in commenting on the display this year. One of them said: "We have had men from London, Japan, Mexico, Costa Rica and other foreign places visit our booth. More than the usual interest has been shown in the exhibits this year." Another exhibitor said that he felt that he had received greater returns from his exhibit on one day this year than he had from the entire convention last year. Possibly one element in this was the fact that the exhibit was better arranged to attract attention and that the possibilities of the device which he represented were better understood than they were a year ago. Another exhibitor said: "It seems to me that double the interest has been shown in inspecting the exhibits by railroad men this year than at any other convention I can remember."

Referring to the relative importance of exhibiting old and new devices, one exhibitor had this to say: "While it is true that the articles that have become standard, when shown here would not attract the same attention that a new device that has great merit is certain to receive, the railroad men are overlooking nothing that is of importance to them. We have learned, in showing side by side a well known article and an article we are exhibiting for the first time, that the railroad men have an incidental interest in the old because it is standard, but they search out the new."

It is quite common for a number of the higher executive officers to attend the conventions. Among those present this year were Vice Presidents Thompson, of the B. & O., and Thorne, of the Union Pacific; General Managers Long, of the Pennsylvania; Needles, of the Norfolk & Western; Baker, of the Queen & Crescent, and Bardo, of the New Haven. In addition a number of operating and purchasing officers also visited the pier.

Another feature which is not new, but which is worthy of special comment because it promises to do much in securing a better understanding between the railway officers and the government regulating bodies, is the attendance of men connected with the work of the Interstate Commerce Commission. Secretary McGinty, especially, takes a keen interest in the work of the associations and the exhibits, and is closely seconded by the heads of the locomotive boiler inspection department and the safety appliance division and such of their inspectors as are able to visit Atlantic City.

Railroad officers who have had the opportunity of becoming well acquainted with these men, and who have taken the trouble to get their viewpoints, cannot but be impressed with the fact that they are honestly trying to so administer the departments over which they preside as not to unnecessarily embarrass the railways and yet to eventually bring about conditions which will prove to be best for the railways as well as the general public. The keen interest which they are taking in the work of the two associations is greatly appreciated, and it is to be hoped that even more or the inspectors will find it possible to be with us next year.

Summed up in the words of one of the officers of the Association: "All of the frills have been cut out and we have got down to a good, solid, working basis. I regard the progress which has been made as one of the greatest forward steps that have ever occurred in the history of our Association."

FINAL REGISTRATION OF M. M. AND M. C. B. MEETINGS

The accompanying table gives the final results of the registration at the close of the conventions.

BOOK NO. 6

	1912	1913	1914
Members M. C. B. and M. M.	668	700	758
Special guests	684	724	612
Ladies, railroad	471	521	467
Ladies, supply	223	312	288
Supply men	1523	1680	1497
Total	3569	3937	3622

LITTLE INTERVIEWS

Although "Billy" Pine, of the Railway Utility Company, is one of the most optimistic on business conditions, he says: "I think the low tariff is the thing that is curtailing business just now. In this morning's paper I see that April imports of 27 classes of commodities were 127 per cent greater than in April, 1913. This is hurting American manufacturers. Some of the textile mills are running only three days a week. The railroads, of course, feel this keenly. On the other hand, the unparalleled western crop conditions coupled with the good prospects for a freight rate increase, make the outlook for the future very good, indeed."

H. L. COLE ON AMERICAN AND INDIAN RAILWAYS

Among the visitors at the convention this year is H. L. Cole, assistant secretary, Government Railway Board of India, Simla, Ind., who is spending some time in the United States and Canada studying railway mechanical matters. Mr. Cole expressed himself as greatly impressed with the character of the exhibit and its extensiveness. In speaking of railway matters he said:

"I am just giving impressions and not settled convictions, as I have not had time to digest all that I have seen. I have certainly had a number of previously-held ideas confirmed since I came over here, but I have had to jettison many ancient and much-cherished convictions. One of them is that a locomotive in America is given a short life and a merry one. I think under your pooling system it probably leads a faster life than our sober, assigned engines, but as regards the actual work you get out of your locomotive, figures given to me show that you get fully as big a life mileage as we do, whether you take it in years of service or actual miles run; and as regards comparing your practice with practice in India in particular, you are getting sometimes a longer life and apparently almost as big a mileage, except perhaps in case of the years of service obtained from some of our oldest locomotives, which used only to run about 1,500 to 2,000 miles a month. We are doing usually much more nowadays.

"The standard of maintenance, roughly speaking, is the same in this country as it is in England and as it is in India. I have seen a good many of your best shops now, and certainly what I have seen is just what one would deduce from the life of the locomotive. The standard of maintenance is in those shops very high. I am not sure whether in some respects you do not go farther than we do.

"I have only been talking about the standard of maintenance so far as regards the organization for maintenance; an interesting fact brought out by my tour so far is that we require roughly six times as many men in India to get the same work as you do here. There are explanations for that. One is that it takes, broadly speaking, three natives of India to do what is regarded as one man's work in a given period here or in England, and that makes a three-to-one ratio; and another is that the native of India of the artisan class is not raising his standard of living along with the rising standard of wages. The result of that is that instead of putting in 200 odd working hours a month they frequently put in individually only a little over 100. Practically speaking, therefore, the net value of their work is, roughly, one-sixth that of a white man. You see, that hits us pretty hard. It is not merely that we have to use about six times as many men to get the same output, but taking a case in the machine shop, for example, you cannot have the same number of tools as if Americans or Europeans were working there. We may need, say seven or more lathes where you want only four, because some of the days the men will all be in together, although at another time we may have half of them lying idle.

"I find the definition for an engine failure here is decidedly higher than ours and I feel much inclined to make the recommendation that our standard of what constitutes an engine failure should be very considerably stiffened up. You have run a long way ahead of us there; far too far ahead of us, and I do not like our position. If for nothing else, I think this visit has been worth while for that.

"Regarding fuel consumption, from what I have seen, the general practice on American railways is very uneven. There are a few progressive roads making very vigorous attempts to handle this fuel economy question. It is about the toughest thing we have had in front of us. I am strongly in sympathy with the Santa Fe in the fight they are putting up there to obtain adequate statistics. We do not want a mass of figures to use for clubbing the engineman, but we want figures promptly, and exact figures to use rather as a guiding light to show where we are going, and where we want to go next, and if we do not get accurate performance figures, we are not going to get any further.

"A considerable amount of the mileage of the Indian State Railways is 5 ft. 6 in. gage and the broad gage has certain drawbacks. In one case it was considered that it would prove advantageous to employ Mallet compounds on certain heavy freight work, but it was impossible to make use of this type of engine because of the broad gage and its consequent close restrictions on clearance limitations. I have been much interested in American railway stations, particularly the Pennsylvania and the Grand Central stations in New York City, but I have been disappointed in the condition of American track in general; it is somewhat inferior to either British or Indian roadbeds. However, the easy riding qualities of your coaches compensate for this in a large measure.

The Indian State Railways use steel cars practically entirely for freight service and despite the high temperatures encountered we experience no trouble from sweating. The cars are generally ventilated, this being a necessity, as they have in many cases to be constructed for the transportation of horses for military purposes whenever the government finds this necessary. I have been greatly impressed with the progress made in mechanical matters on American railways within the past ten or fifteen years, particularly along the lines of steel passenger equipment and the beauty which has been attained in many cases in the fitting up of the steel interior of such cars."

Mr. Cole came to America from England and will return there where he will spend some time before his return to India. He expected to be met in Atlantic City by Mrs. Cole, whom he left in England, but she has been unable to get over.

THE ELECTRIFICATION OF THE BERLIN SUBURBAN RAILWAYS.—A year ago $5,750,000 was voted for the electrification of the Berlin suburban railways and during the last month the first train built for these lines began its trials on the Bitterfeld-Dessau electric railway. The trial train is made up of twelve coaches, so arranged that it can be divided into two parts, which can be run separately. Several firms are submitting trains of different types, and the system to be adopted will not be finally decided upon until all these have been tested. The scheme is expected to be completed in 1916.

Master Mechanics' Association Proceedings

Reports on Smoke Prevention; Locomotive Tests; Brake and Signal Instructions; Train Resistance, and Fuel Economy

President MacBain called the meeting to order at 9:42 Wednesday morning.

SMOKE PREVENTION

At the meeting of the committee for 1913-1914, a set of five questions were drawn up and submitted to the mechanical officials of the various railways confronted by the smoke problem. Answers were received from 25 roads with a total of nearly 32,000 locomotives.

The following are the five questions asked, with a summary of the answers obtained:

Question No. 1.—Please give full progress covering the application and the efficiency of the smoke-preventing air jets, blower, quick-opening blower valve and arch, recommended in the committee's report to the convention of June, 1913. Blue-prints desired, with description; also give costs.

Four roads having 4,000 locomotives report that they have complete equipment according to Master Mechanics' Association recommendations and are having excellent results.

Seven roads have installed no devices, one of these on account of using fuel oil entirely.

One road reports that it finds no particular value in the quick-opening blower valve as a smoke reducer, but agrees that the other recommendations are smoke reducers.

One road, after extended tests of quick-opening blower valves,

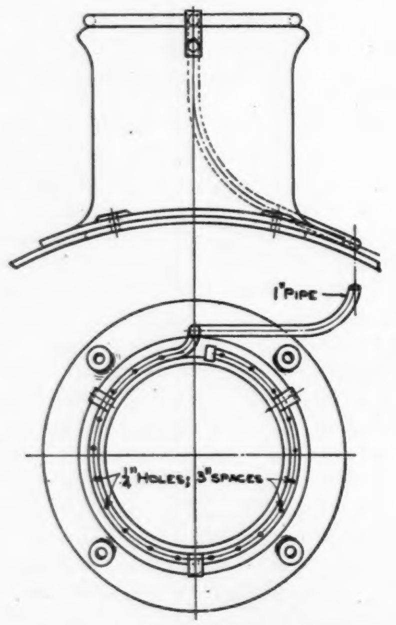


Fig. 1—Smoke Lifting Blower

finds that the smoke can be eliminated 33 per cent. quicker with such valve in use, and as a result of their tests they have decided to adopt quick-opening blower valves. Several other roads agree that its use is effective, especially when unexpected stops are made.

Fifteen roads, with about 18,500 locomotives have installed jets and consider that with ordinary handling these are undoubted smoke reducers. Side installations appear to be more in favor than back-head and are also less expensive. One large road considers that with side installations the jets nearest the front of the firebox are most effective.

Two roads, with over 1,000 locomotives, report that arches effect a smoke reduction while working, but produce no noticeable effect while standing.

One road, with over 1,800 locomotives, reports the application of side jets and blower to all its locomotives switching or running into Chicago, and the extension of such application to all switch engines and a large proportion of all road engines on its entire line; the quick-opening blower valve was applied to only a small portion of these engines.

Question No. 2.—Have you installed on locomotives any special devices other than those recommended by your committee? If so, please send drawings, stating results obtained and costs.

Only seven roads, out of the twenty-five, with about 10,000 locomotives, have tried any special devices other than those recommended.

Two of these reports refer to a different style of arch with a combustion chamber; one considers that the mechanical stoker which it is using, when working properly, is an excellent smoke reducer.

Two roads have tried other devices without success.

One road, with about 1,600 locomotives, reports considerable

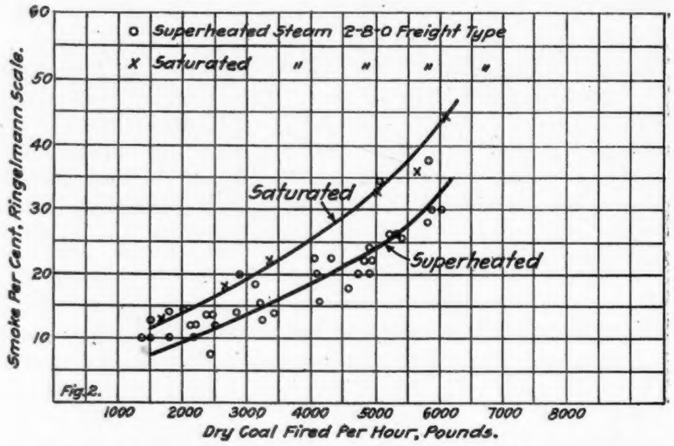


Fig. 2—Smoke Density from Saturated and Superheated Steam Locomotive

success with the Bates baffle firedoor and Heffron draft regulator.

Another large road has attained considerable success by using a ring blower at the top of the stack. Claim is made of almost complete elimination of the smoke on the road and the prevention of smoke trailing into the cab. Cost is about $7.75. (The device is shown in Fig. 1).

One road reported the application in the corners of the firebox of special castings from which steam and air are admitted above

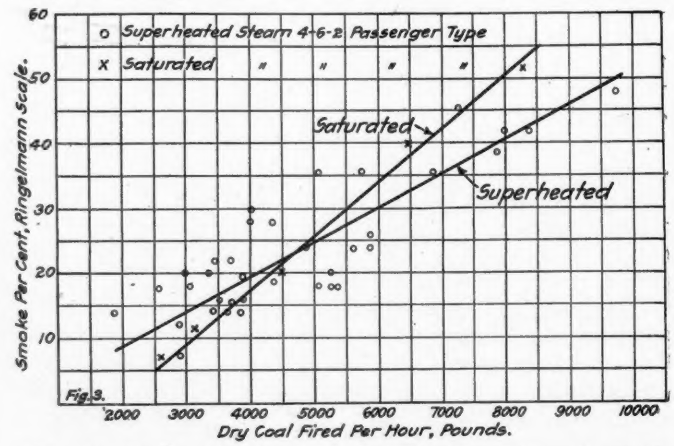


Fig. 3—Smoke Density from Saturated and Superheated Steam Locomotive

the fire, and stated that the apparatus was an apparent success, though no figures were submitted. Another road reported trial of this system with less degree of success than with the apparatus according to the committee's recommendations.

Question No. 3.—Have you installed any special device for handling the smoke from roundhouses? If so, please send drawings, give results obtained, cost of plant and of its operation.

Only one large road* has tried any special devices for handling

* Lake Shore & Michigan Southern at Englewood, Chicago, Ill. See *Railway Age Gazette*, November 28, 1913, page 1022.

roundhouse smoke. One other large road is about to try a device and still another has the matter under consideration.

Question No. 4.—What influence on smoke prevention has the superheater on passenger, freight and switching locomotives? State type of superheater and give coal and smoke efficiencies as compared with saturated engines, as nearly as possible.

Three large roads, having about 4,500 locomotives, consider that there is no reduction of smoke due to the superheater alone, all other conditions of operation being the same.

Two roads believe that when engine is properly worked less smoke will be produced with a superheater than without it.

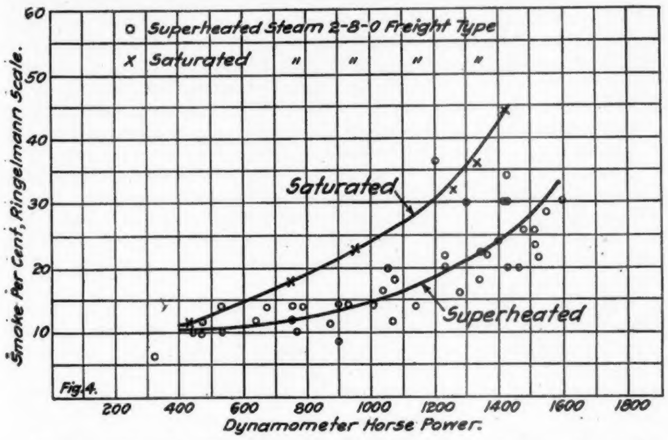


Fig. 4—Smoke Density from Saturated and Superheated Steam Locomotive

This is merely an opinion and not the result of scientific observation.

Five roads believe that there is a reduction in smoke corresponding to the reduction in coal burned by engines equipped with superheaters.

Tests were conducted by the Pennsylvania Railroad at the Altoona testing plant, the results being shown in diagrams Figs. 2, 3, 4 and 5. These tests were conducted with both freight and passenger engines equipped with superheaters against the same type of saturated-steam engines. As may be seen from the curves of the tests, the superheater in freight service effects an undoubted reduction in smoke under the same working conditions. In passenger service, however, the curves indicate that a superheater produces more smoke at the low burning rates, while there is a reduction in smoke at the high burning rates.

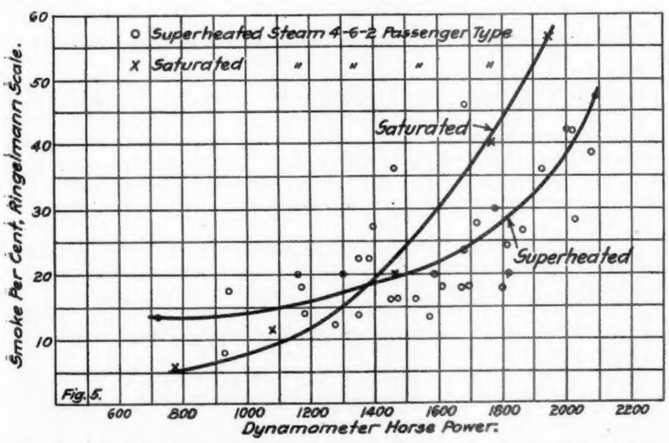


Fig. 5—Smoke Density from Saturated and Superheated Steam Locomotive

The Schmidt superheater appears to be in almost universal use, a few Cole superheaters being the only other ones reported. The fuel economy of the superheater varies from 12 per cent. to 35 per cent. One important road reports a saving of as high as 40 per cent. in the average number of pounds of coal used per car handled in switching service.

Question No. 5.—Have you investigated various methods of firing-up locomotives in roundhouses, with the special object of preventing smoke? If so, give methods and results, with costs, if possible.

One road reports smoke reduction by the use of a ring blower hung inside the stack in a horizontal position.

Another road claims to have reduced smoke about 30 per cent. by leaving the jets on when firing-up. No costs are given, however.

Three large roads have tried different methods of firing-up, with the following results:

In a test with fuel oil and shavings, atomized fuel oil, oil and engine wood, the last named produced the least smoke and was cheapest, the cost being about $1 per engine.

In a test with briquettes, cost about $1.50; soft coal, $2.09; coke, $4.26, briquettes gave as little smoke as coke, and yet, as may be seen, are the cheapest of the fuels tried.

Another road finds that by putting coal on the grates and wood on top that less smoke is produced, but cost figures were not given, and it is believed that this method is more injurious to the grates, especially with coal that clinkers badly.

Another large road, after considerable investigation, has adopted firing-up with scrap waste, crude oil, wood and coal in the following quantities: Waste, 1 lb.; crude oil, ½ pt.; old car siding, ½ cord; coal, 300 lb.

The method employed is to saturate the waste with the crude oil and throw it in on the grate, after being ignited. On top of this, in small bunches, is thrown the wood. When the wood gets to burning in good shape, six to eight scoops of coal are added; then in about thirty minutes more coal is added.

Conclusion.—From the numerous reports above outlined, the committee finds that the application of the apparatus recommended by them last year has proven successful in extended practice toward the elimination of smoke in steam locomotives and suggests its more general adoption.

The report is signed by:—E. W. Pratt, (C. & N. W.), chairman; J. F. De Voy, (C. M. & St. P.); W. C. Hayes, (Erie); T. R. Cook, (Penn.); Jos. Chidley, (L. S. & M. S.); A. G. Kantmann, (N. C. & St. L.), and W. J. Tollerton, (C. R. I. & P.)

DISCUSSION

W. H. Flynn (M. C.): Is this a standing committee?

The Secretary: No.

W. H. Flynn: The committee has given its conclusions, and the information it has been able to get, but it ought to be continued, and come to the next convention with definite recommendations on the practices and special equipment which it would be advisable to follow.

J. F. DeVoy (C. M. & St. P.): Last year's report of this committee did make definite recommendations as to the exact application to engines, both in the rear end and side jets, giving all the information necessary to equip an engine. We have followed out this practice, and in my opinion it will work entirely satisfactorily, so far as reducing smoke from switch-engines is concerned.

Robert Quayle (C. & N. W.): I think this committee should be continued. If you have no trouble in your territory this year, you may expect trouble next year or the year after, because it is very contagious. We very frequently get letters from new smoke commissions, mayors, and others in every State in the union inquiring what we are doing. It looks as though smoke prevention ordinances were to be passed in various other cities throughout the country.

M. K. Barnum (B. & O.): The devices for preventing smoke from locomotives have been pretty well worked out, and if they are used properly, it simply remains to properly educate and supervise the firemen and engineers. Most of the Chicago roads have been using the devices recommended by the commission last year, and the one thing which did most toward their application and the cutting down of the smoke, was the creation of a bureau of railroad inspectors, which was so arranged that each road furnished its quota of inspectors, the inspectors not being limited in their inspection to the engines of their own road. For instance, the Chicago & North Western having six or seven inspectors of their own, will have the benefit of the observation of the other fifty or sixty inspectors who were serving the various roads in the city. That makes the engine crews very careful regarding smoke emission in whatever part of the city they may be working. Before this plan was put into effect an engine crew would be careful when they were on the rails of their own company, but if they would go into another yard, as the transfer engines do every day, they would become careless. This practice has resulted in a very great reduction in the number of smoke violations.

D. F. Crawford (Penna. Lines): I want to speak in support of the motion that was made to continue this committee. The smoke problem is just commencing. The City Smoke Inspector of Pittsburgh. Mr. Henderson and myself, as well as representatives of the other lines, have had frequent meetings and we are endeavoring to work out some plan that will assist in reducing the smoke in and around Pittsburgh, by eliminating as far as possible the smoke from locomotives. A few weeks ago there was introduced into the City Council an ordinance

compelling the use of coke on switch engines. Some ten years ago we had experience in endeavoring to use coke on switch-engines and we do not want to endeavor again. The locomotives that we are using in switching service are provided with a modification of the jet recommended by this committee. The modification consists in surrounding the air opening with a shell-shaped casting and introducing a tube, about half an in. thick, made of felt, in the terminal opening, just before the air enters the firebox. The idea is to produce a muffler to reduce the noise made by the steam jets. With such a muffler the engineman will be more likely to use the device when the inspector is not around. There is some work for the committee, further, on the jets. The muffler is an important part of the proposition. At one engine house, in the Pittsburgh district, we have put up a stack 150 ft. high, with concrete ducts under the floor of the engine house, and smoke jacks that resemble, somewhat, the standard water crank. We have a fan coming and hope to so dilute the smoke produced by firing up that we will remove a cause of great complaint from our neighbors where this engine house is located. I think the committee can well afford to devote some time to the study of devices of this kind. I mean to include not only the several smoke washers that have been produced, but a very interesting device for precipitating smoke by high tension electricity. I think it will be possible, judging from a small experiment, to introduce in our Alleghany engine house a battery of smoke precipitators, working with high tension electricity, requiring a comparatively small amount of power.

W. H. Corbett (M. C.): We have, on some of our engines in the City of Chicago, smoke jets entering the sides of the firebox. The jets are inside of the combustion tube, and they are very noisy. We have two engines now working there with a quick opening blower valve and the jets set back outside of the firebox three inches away from the combustion tube. This diminishes the noise very greatly. The engineers that have been running these two engines gave me a letter, a short time ago, stating that with the quick-opening blower valve there is absolutely no reason why an engine should make black smoke. I believe there is only one good smoke consuming device made, and that is the engineer and fireman. If you cannot educate them to obey the rules, all the devices you can place on the locomotive are of very little value.

O. M. Foster (L. S. & M. S.): We found it very difficult to get the best results from the engineer and fireman unless they were kept together in regular crews. In the City of Chicago, where we had considerable difficulty in meeting the requirements of the smoke ordinances, we made a very great improvement, and in fact accomplished about all that could be desired, after we had kept the engineer and fireman together.

We have tried and are going to the general use of the smoke-consumer jets in firing up engines in roundhouses. We connect the house blower into the smoke consumer system on the engine. By this means under any method of firing-up the engine, the emission of smoke may be expected to be reduced 50 per cent. We have smoke washer in operation in our roundhouse at Englewood and, as a rule, there is nothing escaping from the stack, which is 50 feet high, except a light vapor.

J. W. Fogg (B. & O., C. T.): There is only one smoke consumer, and that is a good fireman and a brick arch in your locomotive. (The committee was continued and made a standing committee.)

LABORATORY AND ROAD TESTS FOR LOCOMOTIVES

The committee has prepared a code for the testing of locomotives, both on the road and in the laboratory, which is submitted for approval and adoption.

Laboratory Tests

The object of a laboratory test is to determine the steam and coal consumption per unit of power when the locomotive is operated under fixed conditions. All driving wheels should be turned to same diameter and should be standard contour. Each pair should be checked to see that they are correctly quartered for the crank pins.

If the locomotive selected has ever been through the shops for general repairs, the frames should be tried to see that they line with the cylinders. The boiler tubes must be new or newly pieced, so as to be free from boiler sediment. The steam cylinders should be approximately the same diameter and as near to that called for as standard for the class of locomotive, as practicable, and they should be bored if not in good condition. The piston packing rings should be in good condition.

On *D* valve type of locomotive the valves and seats should be faced, and on piston valve type old bushings should be bored if not in good condition, or new bushings applied. Piston-valve packing rings should be examined and in good condition, after which a test pressure of at least 60 lbs. should be applied to the steam pipes to determine that the throttle, steam pipes and exhaust passage are tight.

The front end arrangement for the locomotive should be carfully gone over and checked with the print in accordance with which the front end is supposed to have been applied. The stack and draft pipe should be lined to determine that it is properly erected with reference to the exhaust nozzle. Steam joints in the injector and delivery pipes should be tested to determine that they are steam tight. The lift of the throttle valve should be determined for each live notch on the throttle-lever quadrant. When necessary, the cut-off should be taken for each notch on the reverse-lever rack.

The locomotive selected should reach the locomotive testing laboratory at least four days prior to the time when it is scheduled to go under test, in order to permit the application of all instruments and to take the necessary measurements of various parts of the locomotive.

Fuel.—For efficiency tests of locomotives, a standard coal should be selected that can be easily obtained on short notice, and in accordance with the special object in view. If maximum efficiency or capacity is desired, the coal should preferably be some kind that is regarded as a standard for the locality where the locomotive is operated.

Apparatus and instruments.—The apparatus and instruments required for laboratory tests of a locomotive are as follows: Platform scale for weighing coal and ash; tanks and scales for weighing water; graduated scale attached to water glass; pressure gages graduated to at least pounds, for boiler, branch pipe, receiver, exhaust and at other points as is required; draft gages for smoke box, fire box and ash pan; thermometers for

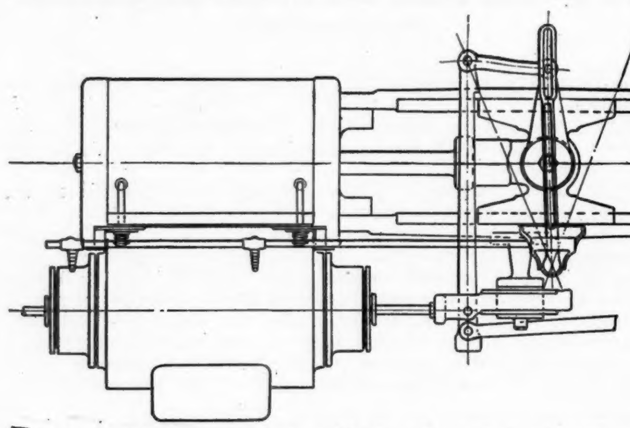


Fig. 1.—Indicator Reducing Motion for Laboratory Tests

calorimeter, branch pipe, receiver and exhaust; pyrometers for fire box, smoke box and at other points as is required; steam calorimeter; steam cylinder indicators; some form of speed recorder to denote the revolutions of driving wheels; gas analysis apparatus; friction brake apparatus; dynamometer for determining the pull at drawbar, and some form of indicator rigging.

In addition to the above, it will be necessary to have planimeters, micrometers, scales, calculating instruments, etc. A calibration should be made by water glass method of both safety valves, and a correction made during a test. The scales, gages, thermometers and pyrometers should be carefully calibrated at specified intervals.

Application of Instruments.—The pressure gages for boiler, branch pipe and exhaust should be connected with a long siphon and located at convenient points for the observers. Care should be taken to make correction for pressure should the gage be located so that the water head would affect the reading. For taking temperature of steam in branch pipe and exhaust passage, thermometers should be inserted into wells, and given proper depth of immersion.

The indicator reducing motion should be some form of pendulum type with light tube for transmitting the reduced motion to a point near the indicator. The pipes leading from the cylinder to the indicator should be not less than ½ in. inside diameter, and they should connect into the side of the cylinder rather than into the heads, thus making a very short connection. Short bends in the pipes should be avoided and they should be well lagged to prevent radiation.

A light framework should be secured to the cylinder to act as a brace for the indicators, and for the motion-rod supports. Absolute rigidity is highly essential in this particular. Care should also be taken to set the indicators in such a position, that

the finger on the end of the motion rod travels in a direction pointing to the groove in the drum proper. See Fig. 1.

Draft gages consisting of *U* tubes properly graduated in inches, containing water, should be placed at convenient locations, and connected at the smoke box or any other point at which the draft is taken, with a ¼-in. pipe. A rubber tube connection should be provided to connect the draft pipe with the *U* tube. In the smoke box the pipes should be located at the horizontal center line of boiler in front and back of diaphragm. The end of the draft tube should be capped and six equally spaced 9-64-in. holes should be drilled through the cap and pipe a short distance back from the end of the pipe.

The draft in the fire box should be taken through a drilled stay bolt, located at a point about half the length of the fire box and about 24 in. above the grates. The draft in the ash pan should be taken at some convenient point at about the center of the entire grate area.

The smoke box pyrometer or thermometer should be inserted so that the hot point or bulb is below the tip of the exhaust mozzle and in front of the table plate. If a thermometer is used for this purpose, it should be graduated to 1,000 deg.

The tube placed in the fire box for inserting the pyrometer should be located opposite the stay bolt drilled for the draft.

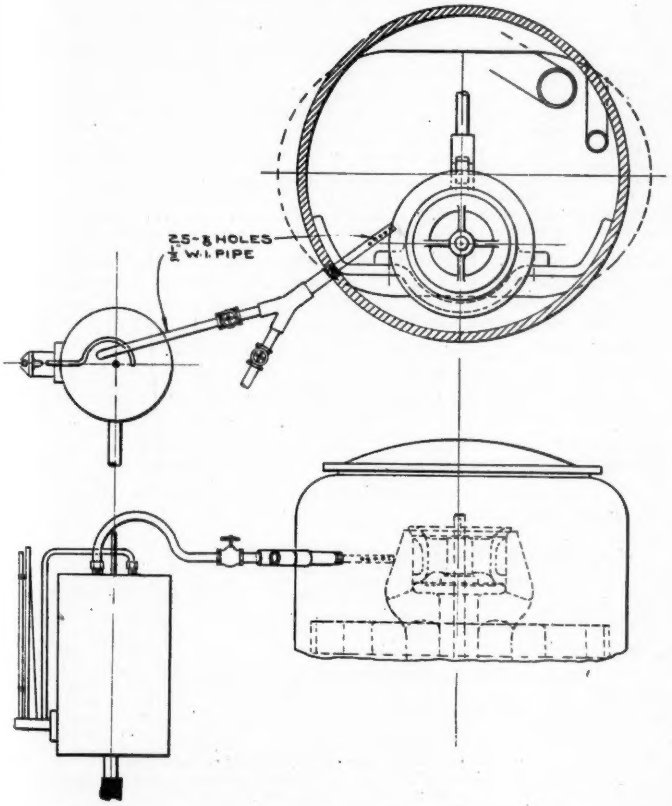


Fig. 2.—Location of Sampling Pipe for Steam Calorimeter

This tube should be a piece of two-inch boiler tube and located on the center line of a stay bolt.

The gas sampling pipe should be located at the smallest area under the draft plate, and in the center of this area. This pipe should have numerous drilled holes equally spaced and the total area of the holes should not be more than the inside area of the sampling pipe.

A steam calorimeter should be attached either at the dome at a point close to the throttle valve, or to the branch pipe according as it is desired to obtain the character of the steam at one point or the other. The former location is preferred. A perforated ½-in. pipe should be used for sampling and conveying the steam to the calorimeter as shown in Fig 2.

Operating Conditions.—In a laboratory test where maximum efficiency is the object in view, there should be uniformity in such matters as steam pressure, quantity of coal supplied at each firing, thickness of fire and in other firing operations. The rate of supplying the feed-water should be uniform through the entire test, and a certain level (about second gage cock), should be maintained from start to finish of test.

The duration of a laboratory test of a locomotive will depend upon the character of the fuel used, rate of combustion and working limitations of the revolving parts. The test should preferably be continued until at least 25 lbs. equivalent evaporation of water per square foot of heating surface has been obtained. If from the graphical log the coal and water performance are uniform, tests of three hours will be the limit.

The fire having been thoroughly cleaned and banked when necessary to permit coking, previous to starting the test, the bank should be broken up and fresh fuel supplied. The locomotive should be started and run at the speed of the test a sufficient length of time to build up a level fire, and which should be, as near as possible, so maintained throughout the test. When all conditions of fire and speed have become uniform, the thickness of the fire should be noted, but the starting signal for the beginning of the test proper should not be given until the locomotive has been run at least 10 minutes. Observe the steam pressure and time and record the latter as the starting time of test. Water level should be maintained uniformly throughout the test. The ash pan should be cleaned at the starting signal. When the end of the test approaches, the fire having been kept at a uniform thickness during the run, the time and water level should be noted and test stopped. When the test is completed the ash pan should be cleaned and cinders, if any, should be removed from the smoke box.

A log of the data should be entered on printed forms and records taken at 10-minute intervals, unless a special test is in progress, where the readings may be taken more frequently. The coal should be weighed out in not less than 300-lb. lots and the time taken for each lot burned. Weighing tanks of sufficient capacity should be provided to maintain water in the supply, varying in head not more than 6-in., and readings of the water consumed should be plotted upon the graphical logs at convenient regular intervals. Indicator diagrams should be taken at the same periods the other data are taken. A sufficient number of observers should be supplied in order that all important observations should be taken simultaneously.

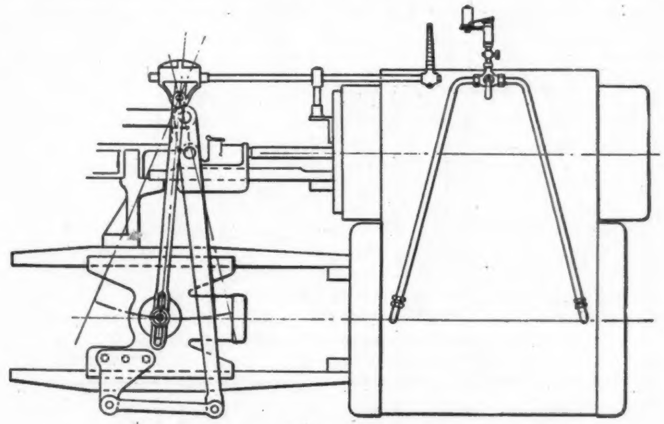


Fig. 3.—Indicator Reducing Motion for Road Tests

Coal Measurements.—Ash and all the refuse withdrawn from the ash pan and smoke box at the end of the test should be weighed in a dry state, and if desired, sample taken for analysis of heating value and unburned carbon. If the coal to be tried is more than the amount necessary to make the test, it should be sampled according to the recommendations of the committee of the American Chemical Society governing carload sampling which are as follows: Six shovelfuls should be taken along each side and six across the center of the car. If the car is to be unloaded into bins, a small amount of coal should be taken off the conveyor buckets or wagons while the entire car is being unloaded. In all events the sample should not be less than 300 lb., and after it is crushed and quartered about one quart should be taken and placed in an air-tight jar for chemical analysis. On all tests the total moisture should be used in the calculations.

The analyses commonly made are what are termed "proximate" analyses; these consist in the determination of the following items: Fixed carbon, per cent; volatile matter, per cent; moisture hydroscopic, per cent; moisture total, per cent; ash, per cent; sulphur separately, per cent, and B. t. u. per pound of fuel.

For complete determinations of the quality of coal, it is necessary to make ultimate analysis, which requires the determination of the following additional items: Carbon, per cent; hydrogen, per cent; nitrogen, per cent, and oxygen by difference, per cent.

DATA AND RESULTS

The data and results should be reported on forms showing the number and sizes of all wheels; the wheel base and gage

of wheels; the weight on the various pairs of wheels with two gages of water and a normal fire; the size and arrangement of cylinders; the cylinder clearance in per cent of piston displacement; the volume of the receivers, the steam port openings; the size of piston and tail rods; a complete description of the valves and type of motion; greatest valve travel; steam and exhaust laps on both sides of all valves; the kind of lagging and jacketing used on the cylinders; the type and size of boiler; complete information regarding all tubes; type of superheater including dimension of tubes and steam area through units; dimensions of the fire box; size and kind of fire doors; style and size of grates including air openings; size, location and ratio to grate surface of air inlets; total heating surface, considering both the fire side and water of the tubes and the fire side of the fire box; water and steam space in boilers; type and dimensions of exhaust nozzle; position of reverse lever; the ratios as follows: fire side heating surface to total grate area, fire area through tubes to total grate area, fire side of fire box to total grate area, fire side of tubes to fire side of fire box, fire box volume to total grate area, and length of superheater units to internal diameter of flues; the constants for the dynamometer horse power and for the indicated horse power at one revolution per minute and one pound mean effective pressure,

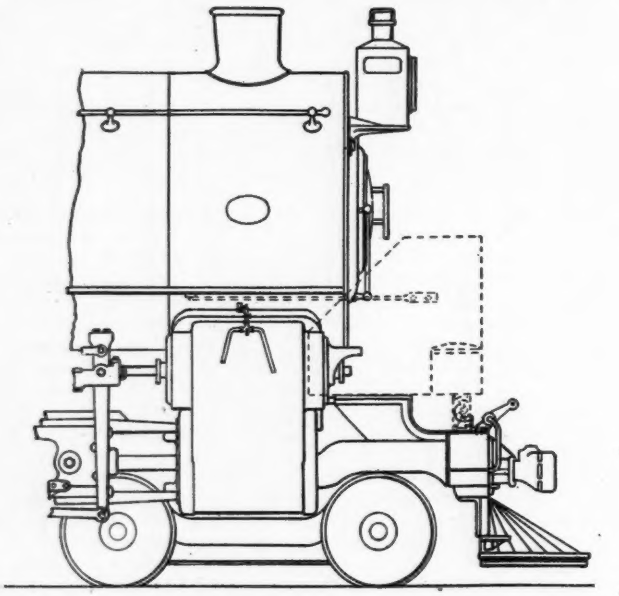


Fig. 4.—Type of Pilot Box for Road Tests

and for both sides of all cylinders; and the piston displacement.

The following is the data that should be obtained during the test:

Duration of test, hours
Hand or stoker fired
Total revolutions
Average .... Per minute
Equivalent speed in miles per hour
Equivalent piston speed in feet per minute
Reverse lever notches from front end
Throttle lever
Temperature of smoke box, by thermometer, degs. F.
Temperature of smoke box, by pyrometer, degs. F.
Temperature of laboratory, dry bulb, degs. F.
Temperature of laboratory, wet bulb, degs. F.
Temperature of steam in branch pipe, degs. F.
Temperature of steam in receiver, degs. F.
Temperature of steam in exhaust passage, degs. F.
Temperature of feed water, degs. F.
Temperature of fire box, by pyrometer, degs. F.
Pressure in boiler, average, lbs. per sq. in.
Pressure in boiler, maximum, lbs. per sq. in.
Pressure in boiler, minimum, lbs. per sq. in.
Pressure in branch pipe, lbs. per sq. in.
Pressure in H. P. cylinder, lbs. per sq. in.
Pressure in L. P. cylinder, lbs. per sq. in.
Pressure in receiver, lbs. per sq. in.
Pressure in exhaust passage, lbs. per sq. in.
Pressure in laboratory, barometric, lbs. per sq. in.
Draft in smoke box, front of diaphragm, inches of water
Draft in smoke box, back of diaphragm, inches of water
Draft in fire box, inches of water
Draft in ash pan, inches of water
Total time right injector in action, hours
Total time left injector in action, hours
Number times right injector used
Number of times left injector used
Quality of steam in dome
Quality of steam in branch pipe
Degrees of superheat in branch pipe
Degrees of superheat in receiver
Degrees of superheat in exhaust
Factor of correction for quality of steam
Coal fired, kind
Coal fired, total
Dry coal fired total, pounds
Combustible, by analysis, total
Ash, by analysis, total
Cinders collected in smoke box, total
Sparks discharged from stack, total
Cinders and sparks, total
Coal loss due to steam loss, pounds per hour
Spark loss, per cent. of total coal fired
Smoke, Ringlemann chart, per cent.

ANALYSIS OF COAL (APPROXIMATE)

Fixed carbon .... per cent.
Volatile matter .... per cent.
Moisture, hydroscopic .... per cent.
Moisture, total .... per cent.
Ash .... per cent.
Sulphur, determined separately .... per cent.
B. t. u. per pound of fuel

ANALYSIS OF COAL (ULTIMATE)

Carbon, per cent.
Hydrogen, per cent.
Nitrogen, per cent.
Ash, per cent.
Sulphur, per cent.
Oxygen by difference, per cent.
Calorific value of dry coal, B. t. u. per pound
Calorific value of combustible, B. t. u. per pound
Calorific value of cinders and sparks, B. t. u. per pound

ANALYSIS OF SMOKE BOX GASES

Oxygen — O .... per cent.
Carbon monoxide — CO .... per cent.
Carbon dioxide — CO_2 .... per cent.
Nitrogen — N .... per cent.
Hydrogen — H .... per cent.
Water delivered to injectors, in lbs.
Water lost, from boilers, in lbs.
Water lost, from, in lbs.
Water lost, from, in lbs.
Water lost, total, in lbs.
Water delivered to boiler and presumably evaporated, in lbs.
Average dynamometer pull in pounds
Maximum dynamometer pull in pounds
Minimum dynamometer pull in pounds

Cut-off, release, beginning of compression, initial pressures from indicator cards, steam chest pressures, pressures at cut-off, pressures at release, pressures at beginning of compression, and least back pressures should be obtained for both ends of all cylinders and the high and low pressure cylinders should be averaged.

SUMMARY OF AVERAGE RESULTS

BOILER

Dry coal fired, per hour .... pounds
Dry coal fired, per hour per sq. ft. of grate surface, pounds

EVAPORATION, POUNDS

Moist steam, per hour
Dry steam, per hour
Dry steam, per hour, per sq. ft. of heating surface
Dry steam, per pound of dry coal
Dry steam, per pound of fuel as fired
Water loss—calorimeter, safety valves, stoker engine, jets, etc., pounds per hour
Dry steam to engines per hour
Factor of evaporation

EQUIVALENT EVAPORATION FROM AND AT 212 ° F

Per hour
Per hour boiler, excluding superheater
Per hour, superheater alone
Per hour, per sq. ft. of total heating surface
Per hour, per sq. ft. of total heating surface, excluding superheater
Per hour, per sq. ft. of total heating surface, superheater alone
Per hour, per sq. ft. of grate area
Per pound of coal as fired
Per pound of dry coal
Per pound of combustible
Boiler horse-power
Efficiency of boiler, based on fuel
Efficiency of boiler per sq. ft. of heating surface
Efficiency of boiler per sq. ft. of grate surface

SUMMARY OF AVERAGE RESULTS, ENGINE

Mean effective pressure, pounds per square inch.

High-pressure cylinder, right, head end
High-pressure cylinder, right, crank end
High-pressure cylinder, left, head end
High-pressure cylinder, left, crank end
Average
Low-pressure cylinder, right, head end
Low-pressure cylinder, right, crank end
Low-pressure cylinder, left, head end
Low-pressure cylinder, left, crank end
Average

RECEIVER

Pressure, right side
Pressure, left side
Average

NUMBER OF EXPANSIONS

Right side, head end
Right side, crank end
Left side, head end
Left side, crank end
Total

INDICATED HORSE-POWER

High-pressure cylinder, right, head end
High-pressure cylinder, right, crank end
High-pressure cylinder, left, head end
High-pressure cylinder, left, crank end
Total
Low-pressure cylinder, right, head end
Low-pressure cylinder, right, crank end
Low-pressure cylinder, left, head end
Low-pressure cylinder, left, crank end
Total

DIVISION OF POWER

High-pressure cylinder, right side
High-pressure cylinder, left side
Low-pressure cylinder, right side
Low-pressure cylinder, left side
Right side, total
Left side, total
Total

PER I. H. P HOUR

Dry coal, pounds
B. t. u. in fuel
Dry steam, pounds
B. t. u. in steam

SUMMARY OF AVERAGE RESULTS, LOCOMOTIVE

Dynamometer horse-power
Dry coal per D. H. P. hour, pounds
Dry steam per D. H. P. hour, pounds
B. t. u. per D. H. P. hour

PER ONE MILLION FOOT-POUNDS AT DRAWBAR

Dry coal, pounds
Dry steam, pounds
B. t. u.
I. H. P. per sq, ft. of heating surface
I. H. P. per sq. ft. of grate surface
D. H. P. per sq. ft. of heating surface
D. H. P. per sq. ft. of grate surface
Tractive power, based on M. E. P. pounds

MACHINE FRICTION OF LOCOMOTIVE, IN TERMS OF

Horse-power
M. E. P. pounds
Drawbar pull, pounds

EFFICIENCY

Machine efficiency of locomotive, per cent
Thermal efficiency of locomotive (based on fuel), per cent

RATIOS

Total weight of locomotive to maximum I. H. P.
Total heating surface to maximum I. H. P.
Test number

SUMMARIZED STATEMENT OF AVERAGE RESULTS

Test No.
Duration of tests, hours
Number of revolutions per minute
Speed, in miles per hour
Throttle opening, full or partial
Actual cut-off, per cent., H. P. cylinders
Actual cut-off, per cent., L. P. cylinders
Area of exhaust nozzle .... sq. in.
Boiler pressure, lbs. per sq. in
Branch pipe pressure, lbs. per sq. in
Receiver pressure, lbs. per sq. in
Exhaust pressure, lbs. per sq. in
Average least back pressure, lbs. H. P. cylinder
Average least back pressure, lbs. L. P. cylinder
Superheat in branch pipe
Superheat in receiver
Superheat in exhaust
Draft in front of diaphragm, inches of water
Draft in back of diaphragm, inches of water
Draft in fire box, inches of water
Draft in ash pan, inches of water
Calorific value of dry fuel, B. t. u. per pound
Dry fuel fired per hour, lbs
Dry fuel fired per hour per sq. ft. of grate
Water delivered to boiler, lbs. per hour
Equivalent evaporation from and at 212°, lbs. per hour
Equivalent evaporation from and at 212°, lbs. per hour per sq. ft. fire heating surface
Equivalent evaporation from and at 212°, lbs. per hour per pound of dry fuel
Boiler horse-power (34.5 U of E)
Efficiency of boiler, based on fuel
Average smoke, per cent
Dry steam to engines, lbs. per hour
Indicated horse-power
Dry fuel per I. H. P. hour, lbs
Dry steam per I. H. P. hour, lbs
Drawbar pull, lbs
Dynamometer or drawbar horse-power
Dry fuel per D. H. P. hour .... lbs.
Dry steam per D. H. P. hour
Machine efficiency of locomotive .... per cent.
Thermal efficiency of locomotive, based on fuel .... per cent.

Road Tests

The object of a road test is to determine the steam and coal consumption of a locomotive per unit of power nuder practical conditions of the locomotive in railroad service. All of the preparations as given in laboratory tests should be carried out preparatory to placing the locomotive in service, with the possible exception of not having all driving wheels newly turned, and equipping the locomotive with the various instruments that can be done while the locomotive is in the shops for repairs.

Fuel.—The same consideration should be given to the fuel as on a laboratory test. To facilitate the measurement of coal and the determination of the quantity used during any desired period of the run, it is desirable to provide sufficient number of sacks, of a size holding 100 lb., and to weigh the coal into these sacks preparatory to starting on the test.

Apparatus and Instruments.—The apparatus and instruments required for a road test of a locomotive are as follows: Platform scale for weighing coal; crane, spring balance and bucket for weighing ash; tank and scales for calibrating the tank; graduated scale attached to water glass on boiler; float for measuring height of water in tank, or, if preferred, graduated scales on all four corners of the tank; pressure gages graduated to pounds for boiler, branch pipe, receiver and exhaust; draft gages for smoke box, fire box and ash pan; thermometers for calorimeter, branch pipe, receiver and exhaust; pyrometers for fire box, smoke box, and at other points as required; air-pump counters; water meters; steam calorimeter; steam-cylinder indicators; some form of speed recorder for the revolutions for the driving wheels in case no dynamometer is accessible. On Mallet type of locomotives two recorders should be used; some form of pendulum-indicator rigging; traction dynamometer for determining pull at drawbar, with its complete equipment; and electrical connection between locomotive and dynamometer.

Steam used for auxiliary purpose other than the cylinders, such as air pump, calorimeter, injector overflow, train lighting and heating and what escapes from the safety valves, may be estimated from data obtained by testing them either before or after the trial. The scales, gages and pyrometers should be calibrated before and after the tests are made.

Application of Instruments.—All of the instruments given under laboratory test should be carried on road tests as far as practicable, with a few exceptions. The indicator rig should be some form of pendulum motion with a light tube for transmitting the reduced motion to a point near the indicator. See Fig. 3. The apparatus which is most suitable consists of a three-way cock for the attachment of the indicator, with a steam-chest connection, so that diagrams can be drawn on each cylinder card and pressure determined. The three-way cock should be provided with a clamp rigidly secured to the cylinder and thus overcome any tendency of the indicator to move longitudinally with reference to the driving rig. The support for the motion rod should be secured to some point on the steam chest. Care should be taken to set the indicators in such a position that the finger on the end of the motion rod travels in a direction pointing to a groove in the drum proper.

The pipes leading from the cock to the cylinder should be not less than ½ in. inside diameter, and if possible not exceeding 36 in. in length. They should be connected into the side of the cylinder, rather than into the heads. Sharp bends in the pipe should be avoided and they should be well lagged to reduce radiation.

If a dynamometer car is not used, stroke counter should be placed at some convenient point in the pilot box to record the revolutions of the drivers. This can be conveniently driven from a finger on the motion rod of the indicator rigging. To facilitate the working of the men who operate the indicators and read the instruments at the front of the locomotive, and to protect them from wind or rain and jolting, a suitable pilot box extending back to the cylinder and properly secured to the bumper beam should be provided. See Fig. 4.

Whenever practicable, the bulb of the thermometers used in branch pipe, receiver or exhaust should come in direct contact with the steam and no wells used. When thermometers are placed in wells, they do not respond quickly with the different changes in the working of the locomotive.

The water meters should be attached to the suction pipes of the injectors, and located at points where they can be conveniently read while the locomotive is in motion. Each meter should be provided with a check valve to prevent hot water from flowing through them from the injectors, and strainers to intercept foreign material. With the water scoops it will be impossible to use a foot, but when tests are made on roads not using water scoops, a suitable float should be made for determining the water consumption. The water level may be established by using a rubber hose with glass tube inserted in the end, which will indicate the height of water in the tank. this tube to be brought in contact with a properly calibrated scale, or, if more convenient, long glass tubes may be provided at each corner of the tank for the same purpose. In all cases the term "branch pipe" refers to the steam-supply pipe to the cylinders and not the injector branch pipe.

The same operating conditions should be maintained as far as practicable as on a laboratory test.

The duration of a test is the running time minus time the throttle is closed, and depends upon the length of the run between locomotive terminals. In fast passenger service the runs should be, if practicable, at least 100 miles long. In service requiring frequent stops and in freight service, the distance may be much shorter. The length of time upon which the hourly rate of consumption and evaporation are based is the total time that the throttle valve is open and not elapsed time between the starting and stopping time.

Starting and Stopping.—The fire having been thoroughly cleaned, banked to permit coking, fresh fuel should be supplied to a level thickness which will be required for the run. After the locomotive is attached to the train, observe the pressure, the water level or meter readings, and when the locomotive starts take this as the starting time. Thereafter cover the fire with weighed coal and proceed with the regular work of the test. The ashes and refuse should be removed from the ash pan and smoke box before the locomotive is coupled to the train.

During the run the fire should be maintained in as equal and uniform condition as practicable, and when the end of the route is reached the fire should be as level and approximately the same thickness and condition as at the start. When the locomotive is stopped and the proper level of the fire obtained, the weighed coal should be discontinued. If during the run a stop of over seven minutes is made, and in order to keep the fire in proper condition fresh fuel must be supplied, this should be selected from the unweighed coal. There should preferably be no water supplied to the boiler, and if it is supplied, allowance should be made for same.

On reaching the terminal, the fire being in the same condition as at the start, the water level and water supply should be noted. The time the locomotive comes to rest should be the time of stop of test.

Records.—The tests should be in charge of a competent person who is thoroughly familiar with road operations. The number of observers required for a test depends upon the nature of the data to be obtained. When making an efficiency test at least six observers should be located on the locomotive, two for taking indicator diagrams and any other data that can be taken from the pilot box, two for cab data and two for coal and water records. It is frequently necessary to increase this force when taking special data.

In the dynamometer car at least four observers are required, one to record the time of each start and stop, passing each station and recording mile posts, point of curvature and tangent and any other important information; one to record all information on the diagram and keep track of indicator cards, and one to take car numbers and weights of trains; this latter man can also act as a relief observer. When making test of Mallet type of locomotive, the locomotive force is increased to take indicator cards from the low-pressure cylinders.

The time to take records depends entirely upon what facilities are available for recording same. If a dynamometer car is available for the tests, records should only be taken when some change in the operation of the locomotive takes place, such as throttle lever, reverse lever and boiler pressure. If the dynamometer car is not available, all records should be taken preferably every five minutes.

Special reading of the meters and total number of sacks of coal fired should be taken at specified stopping and passing points. Careful observations should be made throughout the run, of the time passing all important points, arriving and leaving each station, and the time that the throttle valve is opened or closed, not only at each stop, but when drifting.

Ash and Refuse.—In weighing and sampling the ash and refuse, the same preparation as described for laboratory tests should be followed as far as practicable.

Sampling Coal.—The coal should be sampled while it is being weighed off in 100-lb lots, and a small proportion taken at different times until about 300 lbs is obtained. This should be crushed and quartered and about one quart placed in an air-tight jar and sent to chemist for analysis. When this method of sampling is used, care should be taken that the coal does not take on additional moisture, due to leaky cistern or sprinkler. If there is any question as to the coal taking additional moisture after it is once weighed out, sample should be taken from each sack as they are emptied. On all tests the total moisture should be used in all calculations. The same practice as used on laboratory tests for calorific tests of coal should be used on road tests.

DATA AND RESULTS

The data and results should be reported in accordance with the form given for laboratory tests as far as practicable, and in addition a summarized form should be made giving the following information:

Date of test..........
Average number cars (pushed or pulled)..........
Gross tons, excluding locomotive..........
Number 100 gross ton-miles..........
Number 100 adj. ton-miles..........
Number of stops..........
Distance in miles..........
Time of trip..........
Time running — hours..........
Time throttle open — hours..........
Average speed, running throttle open — M. p. h..........
Average boiler pressure, lbs. per sq. in..........
Average h. p. steam-chest pressure, lbs. per sq. in..........
Average l. p. steam-chest pressure, lbs. per sq. in..........
Draft, front of diaphragm—in. water..........
Draft, back of diaphragm—in. water..........
Temperature feed-water—Degrees Fahr..........
Temperature air—Degrees Fahr..........
Degrees superheat in branch pipe—Degrees Fahr..........
Degrees superheat in receiver—Degrees Fahr..........
Degrees superheat in exhaust—Degrees Fahr..........
Coal and how fired..........
Coal, total as fired, lbs..........
Dry coal per hour fired, lbs..........
Dry coal fired per hour per sq. ft. grate area..........
Water, total out of tender, lbs..........
Water, total evaporated, lbs..........
Water loss—Calorimeter, safety valves, etc., lbs..........
Water evaporated per pound fuel as fired..........

EQUIVALENT EVAPORATION FROM AND AT 212° F.

Per hour, lbs..........
Per hour per sq. ft. total heating surface..........
Per hour per pound coal as fired..........
Boiler h. p. (34.5 U of E)..........
Efficiency of boiler based on fuel—per cent..........
Dry steam to engines—lbs. per hour..........
I. h. p., high-pressure cylinders..........
I. h. p. low-pressure cylinders..........
Total i. h. p..........
Dry coal lbs. per i. h. p. hour, lbs..........
Dry steam per i. h. p. hour, lbs..........
Average drawbar pull, lbs..........
Dynamometer or drawbar horse-power..........
Dry coal per d. h. p. hour, lbs..........
Dry steam per d. h. p. hour, lbs..........
Coal as fired per 100 gross ton-miles, lbs..........
Coal as fired per 100 ton-miles, lbs..........
Water per 100-ton miles, lbs..........
Coal as fired per car-mile, lbs..........
Water per car-mile, lbs..........

The report is signed by:— C. D. Young, (Penn.), chairman; W. H. Flynn, (M. C.); Prof. L. E. Endsley, (Purche Univ.); Prof. E. C. Schmidt, (Univ. of Ill.), and J. A. Pilcher, (N. & W.).

C. D. Young, in presenting the report continued as follows: The Committee has gone over the work of the locomotive test plants and has elaborated upon the items which are usually made use of and under each caption has added additional numbers to take care of future expansion for the code, the thought being that if the association should adopt this report as recommended practice, there will be uniformity in recording the item numbers, so if one member makes a test and refers to item numbers in the detail of the report, it will be apparent to someone else just what he refers to, and in that way we will have uniformity in all tests. In the case of road tests, as in the case of the laboratory test locomotives, the same item numbers are used, in order that various roads may make proper comparison. I move that the report be received and the code as submitted by the committee, be presented for letter ballot for adoption as recommended practice. (The motion was carried).

TRAIN BRAKE AND SIGNAL INSTRUCTIONS

The committee respectfully submits the following:

That portion of the Master Car Builders' and American Railway Master Mechanics' Association Air Brake and Train Air Signal Instructions under the heading "General Instructions" has been revised.

That portion comprising the "General Questions and Answers" has not been dealt with for the reason that the number of different types of brake equipments now in use is so large, and the fact that local conditions of different roads require special modifications in methods of handling brakes so that it would be practically impossible to formulate a series of questions and answers that would be universally applicable. Moreover, the Air Brake Association has a committee on questions and answers that supplies all the air brake information required in question and answer form, and your committee respectfully refers you to the comprehensive list of questions and answers published by that association. The committee recommends, however, that a committee from this association be appointed to confer in conjunction with a similar committee from the Master Car Builders' Association, and the Air Brake Association "Questions and Answers" committee, to the end that the questions and answers shall be kept constantly up to date.

On account of the limited range of action of the present train air signal, the committee desires to bring to the attention of the Association the need of an improved train signal—this with a view of accelerating the development of a signal device which shall be entirely satisfactory in its operation, such signal

to permit of easy and prompt communication both between the train crew and engineman, and the engineman and train crew, under all conditions of service. If it is the desire of the association that this subject be investigated, this committee will be pleased to do so, and report progress at the next convention.

The report is signed by:—R. B. Kendig, (Penna.), Chairman; B. P. Flory, (N. Y. O. & W.); R. K. Reading, (Penna.); T. L. Burton, (W. A. B. Co.); L. P. Streeter, (I. C.); A. J. Cota, (C., B. & B.), and W. J. Hartman, (C., R. I. & P.)

Mr. Flory, of the committee: This same report was submitted to the M. C. B. Association, and it was decided at that time that the questions and answers be left out of the Proceedings of the M. C. B. Association. Our brake and train signal instructions were submitted to the M. C. B. Association for letter ballot, and the new train signal was returned back to the committee. I move that the same action be taken by this Association, that the general questions and answers be omitted from our Proceedings, that the air brake and train signal instructions be submitted to letter ballot and that the new train signal be returned to the committee for further investigation. (The motion was carried.)

TRAIN RESISTANCE AND TONNAGE RATING

In a consideration of train resistance and tonnage rating the following conditions, which will have an influence on the resistance, should be remembered:

Condition of Cars.—Weight of car. Resistance per ton is less with heavy cars than with light cars. Arrangement and number of wheels in trucks. Squareness of trucks or axles. Diameter of wheels and journals. Wheel base of trucks and cars. Condition and character of centerplates and side bearings. Kind of lubrication. Materials of journals and journal bearings. Speed of train. At speeds above 5 or 6 m.p.h. resistance will increase with the speed.

Track Conditions.—Surfacing of track in horizontal plane. Alignment of track. Rigidity of track, especially at joints. Gage of track or endplay between rail and wheels. Curvature —degree and length of curve—and super-elevation used; where curve is compensated, amount of compensation. Grade, per cent and length. Where calculations are made using track profiles, accuracy of profiles.

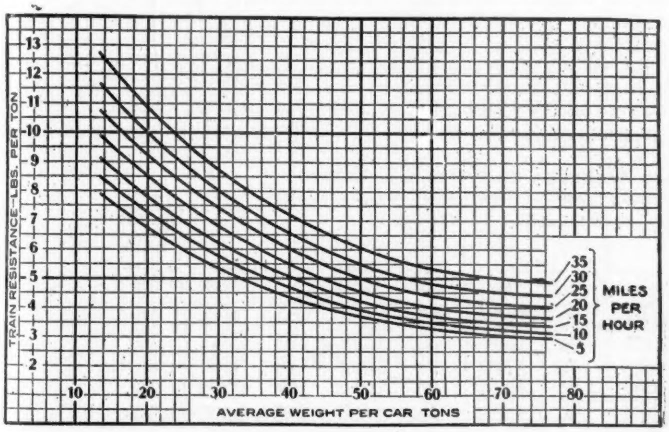


Fig. 1.—The Relation Between Resistance and the Average Car Weight at Various Speeds

Operating Conditions.—Speed of train on ruling grades; with increase of speed, locomotive drawbar pull will decrease, while car resistance will increase. Average speed desired between terminals. Capacity of fireman or mechanical stoker. Condition of fire affected by number of delays. Number of stops. Location of block signals with reference to ruling grade. Location of sidings and other stopping points with reference to ruling grade. Grade of track at sidings. Location of momentum grades.

Weather Conditions.—For highest efficiency, allowance must be made for weather conditions as the locomotive drawbar pull decreases and car resistance increases with low temperature, and wind, which will reduce the locomotive drawbar pull and will increase car resistance.

RESISTANCE AHD TRACTIVE EFFORT

On Fig. 1 are shown curves giving resistance per ton and weight of cars running at various speeds, these being taken from Bulletin No. 43 of the University of Illinois Engineering Experiment Station and Proc. A. R. M. M. A. 1910.

On Table I are shown, for comparison, data from various sources for cars running at about the same speeds. It will be noted that there is considerable discrepancy, and as they are all reported for tests made at summer temperatures, it appears that the reason for this is difference in roadbed and track conditions and to a certain extent in type and construction of trucks.

On Table II are shown data giving resistance per ton and weight of cars running at various speeds which are plotted as results of tests made on the Pennsylvania Lines west of Pittsburgh.

TABLE I. COMPARISON OF CAR RESISTANCE.

From Tests Made By	C. B. & Q.	E.C.Schmidt.	P. R. R.	Penna. Lines, West.
Speed M. P. H.	20	10	8 to 12	10
Weight Per Car, Tons.	Resistance Per Ton in Pounds.			
15	6.30	8.20	8.90	10.00
20	5.20	7.30	7.05	9.05
25	4.40	6.45	5.90	8.20
30	3.80	5.75	5.10	7.45
35	3.40	5.15	4.60	6.85
40	3.10	4.70	4.20	6.25
45	2.85	4.25	3.90	5.75
50	2.70	3.95	3.65	5.35
55	2.50	3.70	3.45	5.05
60	2.40	3.50	3.25	4.70
65	2.30	3.35	3.10	4.45
70	2.25	3.25	3.00	4.25
75	2.20	3.15	2.90	4.10
80	2.10	3.05	2.80	3.95
85	2.05	....	2.75	3.80
90	2.00	....	2.70	3.70

The data availabe relative to locomotive resistance seems to be very meager, 22½ lb. per ton on drivers being the most generally accepted value for all speeds, resistance on engine truck and trailer wheels being taken as the same as that of the same number of axles under a freight car of equivalent weight. The tender resistance is calculated the same as a freight car.

TABLE II.—RESISTANCE OF FREIGHT CARS.

Speed M. P H	6	10	15	20	25
Weight Per Car, Tons.	Resistance Per Ton in Pounds From Tests on Penna. Lines, West.				
15	9.55	10.00	10.30	10.90	11.80
20	8.60	9.05	9.40	9.90	10.75
25	7.80	8.20	8.60	9.05	9.80
30	7.10	7.45	7.85	8.25	9.00
35	6.50	6.85	7.20	7.65	8.30
40	6.00	6.25	6.60	7.00	7.65
45	5.55	5.75	6.10	6.50	7.10
50	5.10	5.35	5.65	6.05	6.60
55	4.80	5.05	5.30	5.70	6.20
60	4.50	4.70	5.00	5.40	5.85
65	4.25	4.45	4.75	5.10	5.55
70	4.05	4.25	4.50	4.90	5.35
75	3.90	4.10	4.35	4.70	5.15
80	3.75	3.95	4.20	4.50	5.00
85	3.60	3.80	4.05	4.35	4.85
90	3.50	3.70	3.95	4.20	4.70

On Fig. 2 are shown pull speed curves for a saturated steam locomotive having a calculated tractive power pressure of 39,688 lb., when mean effective pressure is assumed equal to 80 per cent of boiler pressure. Two of these curves are taken from tests and the others from curves proposed by the two leading locomotive builders of this country. Where a locomotive is equipped with a superheater it will frequently be found that advantage can be taken of the higher pull speed curve of the locomotive when establishing tonnage rating, this increase will usually have to be determined by actual trial.

It will be observed that the data both for car resistance and locomotive tractive effort exhibit considerable variation, and in using the curves submitted, consideration should be given to the kind of track and probable efficiency of operation of the locomotive; also if the limiting grades are very long the trac-

tive effort of the locomotive will be reduced, due to the limit of endurance of the fireman.

Resistance due to grade will be 20 lb. per ton of 2000 lb. per one per cent of ascent. The resistance of cars due to curvature of track depends on various track and speed conditions, 0.8 lb. per ton per degree being much used. For ordinary track, however, 0.9 lb. per ton per degree will be found correct in a great many cases. The curve resistance of locomotive (including tender) is also found to vary. For consolidation locomotives of 1.5 lb. per ton per degree will be found nearly correct for average conditions; for locomotives of longer wheel base or having more wheels the resistance will be greater.

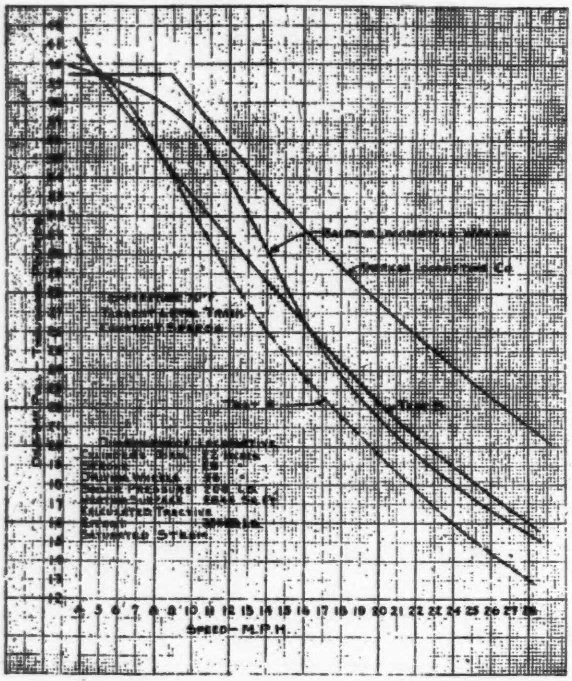


Fig. 2.—Comparison of Pull-Speed Curves of a Locomotive

METHODS OF ADJUSTING TONNAGE

It has been found in practice that the resistance per ton light cars is greater than that of heavy cars, and consequently a locomotive can pull more tons of heavy cars at the same speed and over the same tracks. There are several different ways of covering this point in compiling tonnage ratings, as follows:

Drawbar Pull Method.—In this method the trains of various weights of cars are computed for a locomotive and, due to the varying values of resistance, there will be a different weight of train and number of cars for each average weight of car. The ratings as tabulated are actual tons. This is shown on Table III.

Adjusted Tonnage Method.—In this method the train that a locomotive can haul over a given division are determined by either test or calculation for both heavy and light cars, and an adjusted tonnage rating is determined as follows:

Wl = Total weight of loaded or heavy cars in first train.
We = Total weight of empty or light cars in second train.
Nl = Number of loaded cars.
Ne = Number of empty cars.
C = Car allowance or adjustment factor.

$$C = \frac{Wl - We}{Ne - Nl}$$

Adjusted tonnage loaded cars = Wl + Nl x C.
Adjusted tonnage empty cars = We + Ne x C.

The application of this formula is shown in an example under the head of tonnage for cold weather, and it will be found that the adjusted tonnage for loaded cars will be equal to that for empty cars. This is shown on Table IV.

Variable Car Adjustment Factor Method.—In this method a train of cars of some average weight of car is determined for a given locomotive and the actual tons in this train taken as the rating. In order to provide adjustment for lighter or heaver cars, a factor is added to the weight of lighter cars and subtracted from the weight of heavier cars. The value of the factor is made to vary with the weight of the car, being equal to zero for cars of the average weight tested. This method is in some cases applied in practice by means of a tonnage adding machine which automatically takes care of the adjustment.

COMPARISON OF METHODS

The various methods of applying a tonnage adjustment are shown graphically in Fig. 3. In the drawbar pull method the drawbar pull of a locomotive at 10 m. p. h. was obtained from tests and corrected for grade, and was divided in turn by the resistance per ton of cars of various weights at the same speed. This curve will correctly show the capacity of the locomotive.

In the adjusted tonnage method the weights of trains as calculated for 20 and 72 ton cars were used as a basis for the adjusted tons. The weights of trains composed of cars not weighing 20 or 72 tons were found by adding to the weight of one car the car adjustment factor, which gives adjusted tons per car. Then the engine rating in adjusted tons was divided by the adjusted tons per car, giving number of cars. And finally the number of cars was multiplied by the actual weight per car, giving actual or flat tons in train. This process was gone through for each weight of car plotted.

Table III.—Drawbar Pull Method

Equated Rating for Maximum Grades Wabasha to North La Crosse

Average Weight of Cars	K-1		F-5		F-4		F-3		B-3		B-2		L-2		Average Weight of Cars
Tons	Cars	Tons	Cars	Tons	Cars	Tons	Cars	Tons	Cars	Tons	Cars	Tons	Cars	Tons	Tons
15	134	2010	162	2430	146	2190	127	1905	100	1500	87	1305	205	3075	15
17	125	2125	152	2584	137	2329	119	2023	94	1598	82	1394	193	3281	17
20	115	2300	139	2780	126	2520	109	2180	86	1720	75	1500	176	3520	20
23	107	2461	129	2967	117	2691	101	2323	80	1840	70	1610	164	3772	23
25	101	2525	123	3075	111	2775	96	2400	76	1900	66	1650	156	3900	25
27	97	2619	118	3186	107	2889	92	2484	72	1944	63	1701	149	4023	27
30	91	2730	110	3300	100	3000	87	2610	68	2040	60	1800	140	4200	30
33	86	2838	104	3432	94	3102	82	2706	64	2112	56	1848	132	4356	33
35	83	2905	100	3500	90	3150	79	2765	62	2170	54	1890	127	4445	35
37	80	2960	97	3589	87	3219	76	2812	60	2220	52	1924	122	4514	37
40	76	3040	92	3680	83	3320	72	2880	57	2280	49	1960	117	4680	40
43	72	3096	88	3784	79	3397	69	2967	54	2322	47	2021	111	4773	43
45	70	3150	85	3825	77	3465	67	3015	52	2340	46	2070	108	4860	45
47	68	3196	83	3901	75	3525	65	3055	51	2397	45	2115	105	4935	47
50	66	3300	80	4000	72	3600	63	3150	49	2450	43	2150	101	5050	50
53	63	3339	77	4081	69	3657	60	3180	47	2491	41	2173	97	5141	53
55	62	3410	75	4125	68	3740	59	3245	46	2530	40	2200	95	5225	55
57	60	3420	73	4161	66	3762	57	3249	45	2565	39	2223	93	5301	57
60	58	3480	70	4200	63	3780	55	3300	43	2580	38	2280	89	5340	60
63	56	3528	68	4284	61	3843	53	3339	42	2646	37	2331	86	5418	63
65	55	3575	67	4355	60	3900	52	3380	41	2665	36	2340	84	5460	65
70	52	3640	63	4410	57	3990	50	3500	39	2730	34	2380	80	5600	70

In the Lake Shore method of applying the variable car factor, the adjustment is obtained from a tonnage computing machine, correcting as follows:: A 20-ton car registers 23 tons. A 30-ton car registers 32 tons. A 40-ton car registers 40 tons. A 50-ton car registers 48 tons. A 60-ton car registers 55 tons. A 70-ton car registers 62 tons. An 80-ton car registers 66 tons.

The actual and adjusted tons in a train will be the same when the train is composed of cars weighing 40 tons each. The actual tons calculated or determined by test for the locomotive for 40-ton cars will, therefore, be the rating and the weights of trains of cars of weights other than 40 tons were found by dividing the rating by the adjusted tons per car and proceeding as with the adjusted tonnage method.

In the Philadelphia & Reading method of applying the variable car factor, the adjustment is obtained in much the same way as in the Lake Shore method, except that the constants used are not the same, they being as follows:

Cars weighing from 15 to 19 tons are registered 1 per cent Heavy.
Cars weighing from 20 to 24 tons are registered 3 per cent "
Cars weighing from 25 to 28 tons are registered 2 per cent "
Cars weighing from 29 to 33 tons are registered 1 per cent "
Cars weighing from 49 to 53 tons are registered 1 per cent Light
Cars weighing from 54 to 58 tons are registered 2 per cent "
Cars weighing from 59 to 64 tons are registered 3 per cent "
Cars weighing from 65 to 68 tons are registered 4 per cent "
Cars weighing from 69 to 73 tons are registered 5 per cent "
Cars weighing from 74 to 77 tons are registered 6 per cent "
Cars weighing from 78 to 80 tons are registered 7 per cent "
Cars weighing from 81 to 82 tons are registered 8 per cent "
Cars weighing from 83 to 85 tons are registered 9 per cent "

To obtain the curve as plotted, the adjusted tons per car for cars weighing 20, 25, 30, etc., tons each were computed and

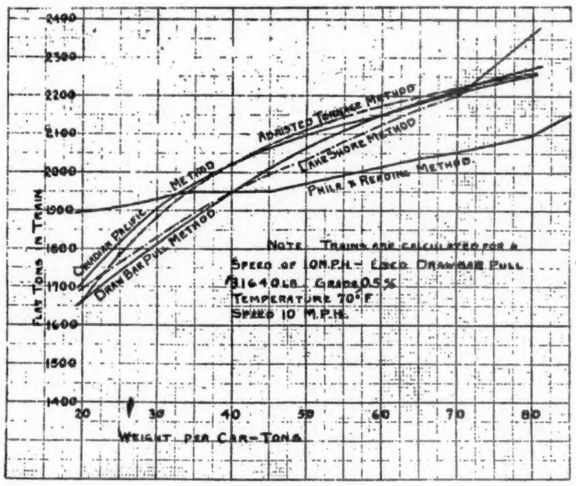


Fig. 3.—Comparison of Tonnage Computed by Various Methods

further calculations made the same as with the adjusted tonnage method.

In the Canadian Pacific method of applying the variable car factor the rating is based on cars having load equal to twice the rate weight of the car. In order to compare this with other methods, cars are assumed as weighing 20 tons tare. Then when loaded in accordance with this method, they will have gross weight of 60 tons per car. From a table current on the Canadian Pacific, upon which tonnages are calculated for grades of 0.5 per cent and under, it is found that when the tare weight of a car is assumed as 20 tons the adjusted weights are as follows:

For total weight of car of 20 tons, adjusted weight is 26 tons.
For total weight of car of 30 tons, adjusted weight is 35 tons.
For total weight of car of 40 tons, adjusted weight is 44 tons.
For total weight of car of 50 tons, adjusted weight is 53 tons.
For total weight of car of 60 tons, adjusted weight is 62 tons.
For total weight of car of 70 tons, adjusted weight is 71 tons.
For total weight of car of 80 tons, adjusted weight is 79 tons.

The adjusted rating is found by dividing the total actual weight of 60-ton cars that the locomotive will haul, as found from the drawbar pull, or 2150 tons, by 60, which will give the number of cars. The number of cars is then multiplied by the adjusted tons per car for a 60-ton car, which will give the adjusted tons per train. To obtain the actual tons in trains of cars of weights other than 60 tons each the same method was used as explained under the Lake Shore method.

A comparison of the various curves plotted on Fig. 3 shows that on a 0.5 per cent grade the Lake Shore method agrees most closely with the drawbar pull method, except for cars above 70 tons in weight. The adjusted ton method is correct for cars weighing 20 and 72 tons each, or if other weights of cars are selected for computing adjusted tonnage, for such weights as may be taken; for other weights of cars the locomotives will be overloaded when average weight per car is between 20 and 72 tons and underloaded when weights of cars are less than 20 tons or over 72 tons each.

The Philadelphia & Reading method agrees with the drawbar pull method at only one point and at other points there is considerable discrepancy. The adjustment used is apparently

TABLE IV.—ADJUSTED TONNAGE METHOD.

ERIE & ASHTABULA DIVISION.

ENGINES.	Resistance, 11 Tons per Car				Resistance, 11 Tons per Car			
	West Bound				West Bound			
CLASS.	A	B	C	D	A	B	C	D
D 9a, D 10a	1100	1025	925	775	925	850	775	650
D 9, D 10	1200	1125	1000	850	1000	925	850	700
4c H 2a, G 3	1350	1250	1125	950	1125	1050	950	775
3c H 2, 3c H 2a, 2c H 2a	1475	1375	1250	1025	1250	1150	1050	875
1c H 2, 1c H 2a, 2c H 3a, 2c H 3b	1600	1500	1350	1125	1350	1250	1125	950
E 2, E 2a, E 2b, E 2c	1675	1575	1400	1175	1400	1300	1175	975
1c H 3a, 1c H 3b, E 28, E 29	1725	1600	1450	1200	1450	1350	1225	1025
2c H 3c	1875	1750	1575	1300	1575	1475	1325	1100
1c H 3c, B 29, J 28	2000	1875	1675	1400	1675	1550	1400	1175
K 2, K 2s/a, K 2s, K 28, G 4	2300	2150	1925	1600	1925	1800	1625	1350
G 4a, G 4b	2450	2275	2000	1700	2050	1900	1725	1425
B 6, B 6s	2550	2375	2150	1800	2150	2000	1800	1500
K 3s	2700	2500	2275	1900	2275	2125	1900	1600
H 4, H 6a, H 6b	2975	2775	2500	2100	2500	2325	2100	1750
H 8a, H 8c, H 8s/c, H 28	3200	2975	2700	2250	2675	2500	2250	1875
H 10s	3750	3475	3150	2625	3150	2925	2650	2200
	Conway to Niles				Niles to Austinburgh			

HAULING CAPACITY OF LOCOMOTIVES
SLOW FREIGHT.

intended for a steeper grade than 0.5 per cent which was used for the plot on Fig. 3.

The Canadian Pacific curve follows that for the adjusted ton methods very closely.

WEATHER CONDITIONS

Experiments made in 1909 by Prof. E. C. Schmidt on the Illinois Central indicates that the frictional resistance of freight cars moving at 10 to 12 m. p. h. is 50 per cent greater at a temperature of zero degrees F. than at 70 deg. F., and in any system of tonnage rating this fact should be remembered. At 20 m. p. h the above figure will be increased to 67 per cent. In addition to the increase in train resistance, the resistance of the locomotive will be increased, resulting in a lower drawbar pull in cold weather. One way of correcting for this is to add to the resistance of the engine truck, trailer and tender

the same percentage as for freight cars, for cold weather. With the locomotive 0.8 of 22½ lb. per ton, the friction of driving wheels, rods, etc., or 18 lb. per ton, will be affected by low temperature, and this amount, 18 lb. per ton, should be corrected in the same rates as the car resistance.

A simple method of correcting drawbar pull for temperatures of 50 degs. F. and below is to deduct 1-2000 of the drawbar pull at 70 degs. and 5 m. p. h. for each degree that the temperature is below 70 degs. F. When a pull-speed curve is used for the locomotive in which the drawbar pull at the rear of the tender is plotted, the resistance at 70 degs. F. should not be deducted from the drawbar pull of the locomotive, but the increase in resistance should be calculated as above outlined and deducted from the drawbar pull, to provide for low temperatures. When the drawbar pull is calculated, both the resistance of 70 degs. F. and increase in resistance due to low temperature should be deducted from the calculated drawbar pull to find that available at the low temperature.

EXAMPLE

Assume a consolidated locomotive weighing, with tender, 156 tons. Weight on truck wheels 10.5 tons, weight on drivers 86.6 tons, weight of tender 58.9 tons. To calculate tonnage handled on a 0.5 per cent. grade at various temperatures when moving at 10 m. p. h.:

At 70 degs. F. there will be no reduction in drawbar pull due to low temperature.

Drawbar pull at 70 degs. F. (Fig. 2—Test B—at 10 m. p. h.), 33,200 lb.

Resistance of locomotive and tender due to grade, 156 x 0.5 x 20 lb, 1560 lb.

Leaving available for hauling train, 31,640 lb.

From the 10 m. p. h. column in Table II:

Rfe = frictional resistance of empty cars, 9 lb. per ton.
Rg = resistance due to grade 0.5 per cent, 10 lb. per ton.
Re = total resistance of empty car, 19 lb. per ton.

and

Rfl = frictional resistance of loaded cars, 4.2 lb. per ton.
Rg = resistance due to grade 0.5 per cent, 10.0 lb. per ton.
Rl = total resistance of loaded cars, 14 2 lb. per ton.

Empty cars weigh 20 tons and loaded cars, 72 tons each.

$$We = \text{weight of train of empty cars} = \frac{31640}{19} = 1665 \text{ tons.}$$

$$Ne = \text{number of empty cars in above train} = \frac{1665}{20} = 83.25 \text{ cars.}$$

$$Wl = \text{weight of train of loaded cars} = \frac{31640}{14.2} = 2230 \text{ tons.}$$

$$Nl = \text{number of loaded cars in above train} = \frac{2230}{72} = 31 \text{ cars.}$$

C. = Car allowance factor (adjusted tonnage method) =

$$\frac{2230-1665}{83.25-31} = \frac{565}{52.25} = 10.8 \text{ tons per car.}$$

Train loaded cars, 2230 + 10.8 x 31 = 2230 + 335 = 2565 adjusted tons.

Train empty cars, 1665 + 10.8 x 83.25 = 1665 + 902 = 2567 adjusted tons.

At 10 degs. below zero the drawbar pull at 70 degs. F. will be decreased by 57.2 per cent of the calculated resistance. (See Fig. 5.)

The calculated resistances are as follows:

Engine truck weight 10.5 tons corresponding to one axle of a 42-ton freight car, resistance per ton from 10 m. p. h. column in Table II is 6.0 lb. per ton, or for the engine truck, 63 lb.

Tender corresponds to a freight car weighing 58.9 tons, resistance per ton from Table II is 4.75 lb. or a total weight of 280 lb.

Resistance of driving wheels which will be affected by low temperature 18 lb. per ton, or a total of 18 x 86.6, 1560 lb.

Total resistance of the locomotive and tender which is used as a base for decrease in drawbar pull when weather is .... cold, 1903 lb.

At 10 degs. below zero the drawbar pull at 70 degs. F. will be decreased by 57.2 per cent of 1903 lb., or 1088 lb.

The drawbar pull available will then be 31,640 lb. less 1088 lb., or 30,552 lb.

Frictional resistances of cars will be increased 57.2 per cent of their values at 70 degs. F.

Then for empty cars:

Rfe = Frictional resistance, 9 lb. x 157.2 per cent, 14.14 lb. per ton.
Rg = Resistance due to grade 0.5 per cent, 10.00 lb. per ton.
Re = Total resistance of empty cars, 24.14 lb. per ton.

and for loaded cars:

Rfl = Frictional resistance = 4 2 lb. x 157.2 per cent = 6.6 lb. per ton.
Rg = Resistance due to grade 0.5 per cent = 10.0 lb. per ton.
Rl = Total resistance of loaded cars = 16.6 lb. per ton.

Empty cars weigh 20 tons and loaded cars 72 tons each.

$$We = \text{weight of train of empty cars} = \frac{30.552}{24.14} = 1265 \text{ tons.}$$

$$Ne = \text{number of empty cars in above train} = \frac{1265}{20} = 63.25 \text{ cars.}$$

$$Wl = \text{weight of train of loaded cars} = \frac{30,552}{16.6} = 1840 \text{ tons.}$$

$$Nl = \text{number of loaded cars in above train} = \frac{1840}{72} = 25.55 \text{ cars.}$$

C = car allowance factor (adjusted ton method)

$$= \frac{1840 - 1265}{63.25-25.55} = \frac{575}{37.70} = 15.22 \text{ tons per car.}$$

Train loaded cars 1840 + 15.22 x 25.55 = 1840 + 389 = 2229 adjusted tons.

Train empty cars 1265 + 15.22 x 63.25 = 1265 + 965 = 2230 adjusted tons.

The conditions for other temperatures may be calculated in like manner, also, if it is desired to use the drawbar pull method instead of the adjusted ton method, the weight of train and number of cars can be obtained by using the resistance per ton corresponding to the weight of the car.

The tabulation below gives data for empty cars of 20 tons and loaded cars of 72 tons computed as above:

Temperature	Flat Tons Loaded Cars	Flat Tons Empty Cars	Adjusted Tons	Car Allowance Factor	PER CENTS. Loaded Cars	PER CENTS. Empty Cars	PER CENTS. Adjusted Tons	PER CENTS. Car Allowance Factor
70°	2 230	1 665	2 565	10.80	100.0	100.0	100.0	100 0
55°	2 150	1 578	2 499	11.65	96.5	94 6	97.3	108.0
35°	2 045	1 465	2 413	12.95	91 6	87 9	94.0	120.0
20°	1 970	1 395	2 343	13 60	88 4	83.7	91.3	126 0
10°	1 925	1 350	2 305	14 12	86.4	81.0	89.8	131.0
0°	1 885	1 305	2 275	14.85	84 0	78.3	88 5	137.5
—10°	1 840	1 265	2 230	15 22	82.7	76 0	86 8	141.0

The error involved in considering the capacity curve of a locomotive for loads or empties as a straight line will not be very great and it will be found most convenient to compute the flat tons of empty cars at 70 degs. F., and at zero degrees F., plotting these values in per cent of tonnage at 70 degs. on cross-section paper, and reducing the calculated tonnage by corresponding per cents when the temperature falls far enough below 70 degs. F. to require reduction. This will depend on various local conditions. The actual reduction required for empty cars is somewhat greater than for loaded cars; therefore, if the tonnage is reduced to take care of empty cars, the loads can be handled without trouble.

It will, of course be seen that this reduction in tonnage is made necessary mainly by increase in journal friction. Therefore each grade will require a separate calculation to obtain the correct percentage to add to resistance for cold weather. In cases where grades are nearly the same, similar corrections may safely be made.

TONNAGE RATING SHEETS

Probably the simplest method of preparing tonnage ratings for use of the transportation department is that shown on Table IV. This, however, is subject to some error, as previously explained. It appears that the additional clerical labor necessary in following a system more nearly correct, would be justified, for it will insure the locomotive hauling full tonnage in extra heavy cars and will prevent overloading when cars of medium weight are used. This will increase the revenue per train with extra heavy cars and will eliminate the cost of delays with half loaded or medium weight cars. For this reason Table V is submitted as being a correct method of tabulating tonnage ratings for use of the transportation department.

In this table are shown two sets of figures, one giving resistance in pounds per car for cars weighing from 15 to 100 tons each, calculated from a curve made from the 10 m. p. h. column in Table II, with the addition of resistance due to 0.5 per cent grade; the other set of figures giving the tractive power ratings for various classes of locomotives. The ratings in column headed *A* are for best conditions, while those in columns headed *B*, *C* and *D* are for less favorable conditions, such as low temperature and high wind. In making up trains in accordance with this table, the resistances of the cars are to be added until the sum is equal to the tractive power rating tabulated for the locomotive used.

As explained above, this table covers only resistances on a 0.5 per cent grade and speed of 10 m. p. h. Where the ruling grade is different, the speed desired is different, or the physical characteristics of the division are different, other constants will have to be used and a table of resistances similar to Table V prepared. The tractive power ratings for the locomotives will have to be determined from their dimensions or results of tests.

DYNAMOMETER TRIALS

The following suggestions are offered for the use of the dynamometer car:

All instruments in car, including dynamometer springs, should be carefully calibrated at intervals sufficiently frequent to insure accuracy of all readings.

The locomotive steam gage should be calibrated and diameter of pistons and driving wheels carefully measured.

The correction to be made in drawbar pull for acceleration may be applied in accordance with the following formula:

$$F = \frac{(1 + 0.6w)}{W} \times 31.1 \times \left(\frac{(V_2+V_1)\quad(V_2-V_1)}{D}\right)$$

where F = correction in pounds per ton.
W = weight of car in tons.
w = weight of wheels under car in tons.
V_1 = initial velocity feet per second.
V_2 = final velocity feet per second.
D = distance of acceleration or retardation.
Constants are based on 33-in. wheels.

Another formula which is easily applied in working up dynamometer records is:

$$F = \frac{91.1}{t}(V_2 - V_1)\ (Tt + 1.68\ N)$$

where F = correction in pounds for whole train.
t = time in seconds between readings V_1 and V_2.
V_1 = initial velocity—miles per hour.
V_2 = final velocity—miles per hour.
Tt = weight of train in tons.
N = number of cars in train.
Constant 1.68 is based on $5\frac{1}{2} \times 10$ in. axles and 33-in. wheels.

Where *F* is positive, it should be subtracted from the drawbar pull and when negative it should be added to the drawbar pull.

In working up such tests, the actual grade going around a curve should be used, and the actual curvature noted, as the compensation of the curve, if any, is based on some assumed value of resistance per ton per degree of curvature which may or may not be true for the case in question. In any calculation involving train resistance on curves, only the part of the train which is actually on the curve should be considered.

VELOCITY GRADES

It will in many cases be found that a ruling grade can be approached at a fairly high speed, say from 25 to 45 m. p. h. Where this initial speed can be depended upon, it will, of course, be possible to haul heavier trains than those calculated for a constant speed or dead pull.

$$Gm = 3.5 \times \frac{V_1^2 - V_2^2}{L}$$

where Gm = per cent of grade to be deducted from actual grade.
V_1 = initial speed in miles per hour.
V_2 = speed at top of grade in miles per hour.
L = length of grade in feet.

Having found *Gm* as above, the equivalent grade is found by deducting *Gm* from the actual grade, and tonnage rating is calculated for the equivalent grade, as previously outlined. Physical relations of rise in feet to length of grade in connection with possible initial speed will have to be considered when determining whether or not a grade can be handled in this manner. Other considerations in this connection are the location of stations, towers, water tanks, sidings and block signals, which, if located on the grade, will prevent its being considered as a velocity grade. The various traffic conditions, such as frequency of trains, single or multiple track, and average speed between terminals will all have a bearing on the subject.

SPEED CURVES

There have been several methods suggested of rating locomotives by calculated speed curves. These are open to the objection that the constants used are not correct, as they do not provide for the variations in pull per ton with weight of car, and that it is necessary to assume a given weight of train and make calculations for acceleration and retardation curves for all grades found on the division and finally with these curves to plot a speed curve over the division profile to ascertain the time tween stations.

In view of the amount of theoretical labor involved in the above, it seems that a better way would be to make up some test trains, either by a simple calculation or according to the judgment of some experienced traffic officer, and run them over the road, keeping careful observations of speeds by means of a reliable speed recorder. If a dynamometer car is available, it can be used to ascertain if the locomotive is keeping up to the proper drawbar pull.

RECOMMENDATIONS

To compute the tonnage rating for a division, it is recommended that for track having heavy rails and roadbed with a high degree of maintenance, the car resistance curves shown on Fig. 1 be used; and that for track of lighter rails and roadbed with a medium standard of maintenance, the car resistance figures on Table II be used. For locomotive drawbar pull, a curve similar to the one marked *Test B* on Fig. 2 is recommended.

For weather conditions, provision should be made by making calculations as previously outlined.

TABLE V. TONNAGE RATING AT SPEED OF 10M. P. H. ON 0.5 PER CENT. GRADE.

CAR RESISTANCE.						ENGINE RATING.				
							TRACTIVE POWER RATING.			
Weight per Car.	Rest. per Car.	Weight per Car.	Rest. per Car.	Weight per Car.	Rest. per Car.	CLASS OF ENGINE.	A	B	C	D
15	320	45	705	75	1 075	D9a, D10a	11 600	10 800	9 850	8 200
16	330	46	720	76	1 085	D9-D10	12 700	11 850	10 750	9 000
17	345	47	735	77	1 095	4cH2a-G3	14 250	13 300	12 100	10 050
18	360	48	745	78	1 105	3cH2, 3cH2a, 2cH2a	15 600	14 500	13 200	11 000
19	370	49	760	79	1 115	1cH2, 1cH2a, 2cH3a, 2cH3b	17 000	15 850	14 400	12 000
20	385	50	775	80	1 125	E2, E2a, E2b, E2c	17 750	16 550	15 050	12 500
21	400	51	785	81	1 140	1cH3a, 1cH3b, E28-E29	18 200	17 000	15 400	13 050
22	410	52	795	82	1 150	2cH3c	19 850	18 500	16 800	14 000
23	425	53	810	83	1 160	1cH3c, B29-J28	21 150	19 550	18 250	14 800
24	440	54	820	84	1 170	K2K28G4	24 450	22 650	20 600	17 150
25	450	55	835	85	1 180	G4a-G4b	25 900	24 000	21 750	18 150
26	465	56	845	86	1 190	K2s, K2s/a	27 100	25 100	22 800	19 000
27	475	57	860	87	1 200	B6-B6s, K5s	29 200	27 050	24 250	20 450
28	490	58	875	88	1 210	K3s, H4, H6m, H6a	31 640	29 300	26 600	22 150
29	500	59	885	89	1 220	H8a, H8c	34 000	31 450	28 600	23 800
30	515	60	900	90	1 235	H8sc	37 500	34 650	31 500	26 200
31	525	61	910	91	1 245	H9sa	40 600	37 600	34 150	28 400
32	540	62	920	92	1 255	H10s	43 900	40 600	36 850	30 700
33	555	63	935	93	1 265					
34	565	64	945	94	1 275					
35	580	65	960	95	1 280					
36	595	66	970	96	1 290					
37	605	67	980	97	1 300					
38	615	68	990	98	1 310					
39	630	69	1 005	99	1 320					
40	645	70	1 015	100	1 330					
41	655	71	1 030	....	....					
42	670	72	1 040	....	....					
43	685	73	1 050	....	....					
44	695	74	1 065	....	....					

If the traffic will permit, the calculation of ruling grades as velocity grades is recommended, as it will permit the addition of several cars to the train.

Where desired, speed curves can be plotted for assumed trains over the division. The principal value of this will be in connection with fast freight trains. On account of the great amount of labor involved, it being necessary to make a complete set of calculations for each train assumed, the committee is not strongly inclined to recommend this method, and mention of it has been made only for the purpose of pointing out to the Association a possible way of determining tonnage rating.

After tonnage ratings have been calculated, it is strongly recommended that before being finally adopted several practical tests be run of trains made up in accordance with the new rating. The use of a dynamometer car or speed recorder in such trials is recommended, in order to show: whether the locomotive is working up to its capacity at all times, and whether the locomotive is loaded to its capacity on the ruling grades.

The report is signed by: P. F. Smith, Jr. (Penn.), chairman; W. E. Dunham (C. & N. W.); E. J. Searles (B. & O.); H. C. Manchester (D. L & W.); C. E. Chambers (C. R. R. of N. J.); J. H. Manning (D. & H.), and Frank Zellny (C. B. & Q.).

DISCUSSION.

D. F. Crawford, (Penna. Lines): The committee has made a most excellent report and has given to the Association a record

of the work that has been done. I think, however, it has been just a little too anxious to recommend to the Association conclusions, in suggesting that we adopt any determined resistance formula or published resistance figures with just the short investigation that I know the committee has been able to give this subject. I do not know of a more important subject for the railroads to-day than the proper loading of freight locomotives. We are building larger locomotives to reduce transportation costs by hauling more tons per unit or per train. If we plot the expense of crews' wages against the tons per train, we will find that the slope of our line is decreasing and the opportunity to make greater savings by still larger locomotives, or by increasing the size of the locomotives, is diminishing. We are now reaching a point where the train load is an important proposition. It will be very interesting to note that all of the curves showing the cost of locomotive repairs per ton mile, the cost of coal per ton mile, the pounds of coal per ton mile, the cost of crews' wages per ton mile, follow the characteristic of the car resistance curve, as might be expected.

In going over the details of the report there were several points which, it occurred to me, may make it necessary for me to make a motion to continue this committee and have them investigate this subject further. They have done everything they could with the data available, but I think they may have to make some tests to determine to their own satisfaction just what should be done in some cases.

It does not seem proper to me that the curve resistance allowance should be based entirely on the tons. If we take a train of a given number of tons, and put eighty cars in it, so that the train is partly on the curve and partly on the reverse curve, it does not seem possible that the resistance should be lower than a train of equal tonnage in twenty cars, part of which might be on the curve and part on the tangent, and could not possibly be on the reverse curve. I know all of the so-called authorities have differed more on this subject that on any other I have ever known. You have a very wide range of resistance formulæ to select from—there are some 55 in existence. I note that under varying weather conditions Professor Schmidt determines by his tests that the frictional resistance of freight cars moving at 10 to 12 m. p. h. is 50 per cent. greater at a temperature of zero than it is at a temperature of 70 deg. I do not think that will be borne out by practical experience. In our own experience it is the practice to reduce the lading about 30 per cent.; in fact, in zero weather if there is no storm, no snow or high wind, you can haul pretty close to the full rating, especially on divisions where you can give up the time. The first proposition of tonnage rating is not how much the locomotive will pull, nor is it the car resistance, it is how long you can allow a unit to occupy a given piece of track; the second proposition is the capacity and size of the locomotive and car resistance. I agree in all of the committee's recommendations as to the care and the methods to be used in calculating or determining tonnage ratings, but I would also recommend that no matter what formula, or who devises it, or how carefully it is applied, that it be confirmed by practical tests, such as the committee suggests. Therefore, while I approve the so-called draw-bar pull method of determining and tabulating the tonnage rating, it seems to me the simple system now used by the Pennsylvania Lines West of Pittsburgh, which was devised by L. G. Hawes some twenty years ago, is sufficiently accurate. I would suggest that the committee give that further study, and determine if it is not sufficiently accurate.

W. E. Dunham, (C. & N. W.): Any system of tonnage rating which you decide upon has to be confirmed by actual trial, and anyone who has given very much detailed study to tonnage rating systems and methods will fully appreciate that fact. On the Northwestern we have tried out the method shown in Table IV, and I might say it has worked very satisfactorily on two of our important divisions, main line fast time freight service and a very heavy dead freight service also. The result has been, in our time freight service, that as reported by one of our superintendents a short time ago, we were able to add to our previous trains about one car, and in some cases, two cars.

C. E. Young, (Penna. Lines): In discussing the point which Mr. Crawford has brought up, I would like to point out the fact that the adjusted tonnage method, which is represented in practice by Table IV, appeals to me very strongly on account of its simplicity, with the conditions which we have in the average yard office in making up trains. It is perfectly true there are some slight errors in the rating which would be established by a resistance factor added to any makeup of trains, that is, trains made up of any weight of cars. The drawbar method, if your fundamental data is correct, is correct, and is subject to errors in the same way, namely, that a slight error will creep in in the adjustable method, in that it is very difficult to determine initially the drawbar pull curve of a locomotive. The drawbar pull or what is known as the full-speed curve is subject to error even when you are making proper tests and conducting the work as well as is possible. The handling of the locomotive and the firing together with its method of operation will affect somewhat your curve. I have no doubt but what under certain circumstances, all these curves are entirely correct; if you are establishing a drawbar pull method on any one of these curves, and you have happened to select the wrong curve, the drawbar pull method is subject to a more expensive error probably than the adjusted tonnage method. I have no doubt but with some modification of the valve setting on any engine you can change the drawbar pull curve. If you want a low speed engine, you can fix the valve for a low speed, and if you want a high speed freight engine, you can change it for a high speed engine, and change the characteristics. Therefore, I feel in rating your train it is much more desirable to go to the simplest method, with reasonable accuracy, and I think the adjusted tonnage method gives you that. The tabulation, as shown in Table IV is the practice which we follow, and it is very simple and very satisfactory to the operating department. There is a chapter here on the change in resistance due to change of temperature, and I believe that the figures submitted by Professor Schmidt, although generally correct, are entirely too conservative for the rating of trains. I believe the cuts which will be made by the information given here are too severe for the actual resistance which will be found on the road. It has been our experience if a train has an opportunity after it leaves the yard to warm up, and stay warm during low temperature conditions, that is, the journals have a chance to heat the oil, and the oil rises to a certain viscosity, that if that point is high enough in the journal, that the resistance will be almost the same at higher temperatures, and therefore, this must be given consideration in applying a reduction for tonnage rating. There is one other matter that is a little out of the province of this report, but is so closely related to it, but it seems well to mention it at this time, and that is the application of your tonnage sheets. It has been my experience that you can work up the most satisfactory rating sheets and send them out to ten or twelve divisions and you will find by checking them up six months later that two or three of the divisions are hauling within 90 per cent of the sheets and other divisions are only handling within 50 or 60 per cent of the sheets, as published. An inspection of that generally develops that there are apparently some local conditions in the minds of the division people which justify them.

F. F. Gaines (C. of G.): It has been recommended by some of our members that this subject be continued for another year and be referred back to the committee for further action. In view of what has been said, I think it would be very wise to do that, and, therefore, I make a motion that this subject be referred back to the committee for further investigation along the lines of the discussion this morning.

(The motion was carried.)

FUEL ECONOMY

In the preparation of this report, a list of 17 questions was sent out to the mechanical department heads of the railroads. A digest of the answers is given below.

There is no doubt that clean boilers contribute largely to fuel economy; and it is certain that scale formation leads to broken staybolts, leaky tubes, seams and mud rings, with the consequent loss of boiler efficiency and increased fuel consumption for a given amount of evaporation. Experiments conducted by the United States Government show the following costs for producing 100 h. p. for 3,000 hours with coal at $1.50 per ton, for a clean boiler and with various thickness of scale, as follows:

Thickness of Scale	Cost	Increased Cost
Zero inch	$1,269.99	....
1/8-inch	1,459	14 88 per cent.
1/4-inch	2,030	59.84 "

These data clearly demonstrate the point in question, and show that every 1-16 in of scale on the heating surface of the boiler requires 15 per cent more fuel than would be required if the boiler was entirely free from scale. Scale prevention and careful boiler maintenance have a very marked bearing on fuel economy, perhaps more than any other item in connection with the locomotive itself.

Tests of superheater locomotives in both passenger and freight service have shown a saving in fuel, for a unit amount of work done, amounting to as much as 25 per cent. Somewhat less than this must be expected in regular service, because in every-day

operation the approach to the results achieved by tests will be governed by the essential factors of good firing, proper handling of the locomotive and maintenance. Superheaters make it possible to get a higher sustained tractive power out of a locomotive. The savings resulting from their use, therefore, would not show upon a locomotive mileage basis, but would appear when figured on a ton-mile basis, which is, to a certain extent, proportional to the work done.

Outside valve gear has some influence on fuel economy, because it holds its adjustment and consequently gives a better steam distribution.

It is generally agreed that about 10 per cent. fuel economy can be obtained from the use of the brick arch. But there are other advantages which should not be lost sight of. It affords considerable protection to the flues, by keeping them at a nearly constant temperature and thus prevents certain losses due to leaks; also the arch tubes give increased heating surface of the most valuable kind.

Special appliances, such as automatic fire doors, power reverse gears, rectangular and variable exhaust nozzles, and smoke-consuming devices all have a tendency to produce fuel economy, as they make the work of the enginemen easier and improve the operation of the locomotive itself. Among special appliances might also be mentioned a recording device attached to the safety valve to show how long the valve has been open during any stated period. The railroad with which the chairman of this committee is associated, has had a device of this nature on one of its passenger locomotives for some time. The record made by the instrument is very impressive and admits of no argument. It enables the engineman to be accurately informed of the amount of waste caused by unnecessary popping, and it goes a long way to assist in making instructions along this line effective. A 3-in. safety valve on a boiler carrying 200 lbs. pressure will waste 146.7 lb. of steam and about 20 lb. of coal every minute during which it is open.

Several railroads have organized their fuel departments and placed in charge a fuel engineer, or a superintendent of locomotive operation. This officer reports to the head of the mechanical department. The fuel department has jurisdiction over matters relating to the proper operation of locomotives, economies in fuel, lubricants, other supplies and kindred subjects.

One road has a superintendent of locomotive operation who visits the several division terminals periodically and lectures to the enginemen on the methods of performing their duties in the manner to secure economies in operation.

On some roads a traveling engineer and a traveling fireman are assigned to each main line division, and in some cases they have to cover side lines as well. While other railroads do not require these men to cover so much territory, the plan is not necessarily inefficient, because a great deal depends upon the spirit which the supervising officers are able to work up among the engineers and firemen.

The railroad with which the chairman of this committee is connected has quite an extensive organization of this character. At the head of the department is a superintendent of locomotive operation who reports to the general mechanical superintendent. Under this officer are supervisors of locomotive operation and road foremen of engines, who receive intsructions, both from him and from the master mechanics. The plan of close supervision requires the assignment of at least one supervisor of locomotive operation or road foreman of engines to every 50 engine crews or less, each man having supervision over one specific class of service, namely, passenger, freight or switch. Their duties cover instruction of enginemen in the proper methods of firing, efficient handling of the locomotive, and operation of fuel-saving devices. They also hold periodic class meetings at the different terminals, where the road instruction is carried further by lectures.

Enginemen receive encouragement by a system which has been in vogue on this road for several years. When an engineer has had a record which comes up to a certain fixed standard, the number plate of his locomotive is painted red, indicating that he is a member of the order of the "Red Spot." The rules governing this order are briefly as follows:

A good performance in operating the locomotive, both in controlling the work of the fireman and in performing his own duties so as to obtain the greatest efficiency in operation.

His record must show no engine failure, for which he is directly responsible, during the preceding six months. Cleanliness is also an essential.

They are required to make a study of the four leading economies over which they have control; namely, fuel, lubrication, tools and other supplies, and maintenance and shop cost of locomotives.

Membership shall be chosen and published on the first day of each month by a committee composed of a master mechanic, a supervisor of locomotive operation or a road foreman of engines, a trainmaster, a chief dispatcher and a superintendent (ex officio).

Engineers or firemen in charge of a "Red Spot" locomotive becoming amenable to discipline shall receive the following benefits:

Record Suspension	None.
Actual Suspension	Reduced one-half.
Dismissal	Due consideration.

If any offense warrants the application of the above modified discipline, the locomotive loses its "Red Spot," but it may be changed back at the beginning of any month by recommendation of the committee. After an engineer has belonged to the order a sufficient length of time to warrant it, his name is placed on the cab of his locomotive in letters of gold. This is the highest position in the order.

Class or individual instruction is very essential to promote the greatest degree of fuel economy, and in most cases, both are given. Individual instruction is preferred. However, in order to create a lasting impression and obtain the best results, instruction should be followed up invariably by practical demonstration. Locomotive class instruction at terminals is growing in favor.

Most roads have what are called progressive series of examinations, that is, examinations pertaining to the firing and operation of locomotives, which each fireman must pass before he can be promoted to fill the position of engineer. The first two years are generally devoted to questions of combustion and fuel economy, while the third year covers the subject of air brakes, the mechanical parts and operation of the locomotive. Examinations are conducted by the supervisors and road foremen and are followed by the trainmaster or chief dispatcher who gives a thorough examination of train rules and signaling, after which the candidate, if qualified, is ready for promotion. The instruction should cover transportation rules and signaling as well as the rudiments of proper firing. Certainly the instruction of new firemen should receive more serious consideration than has been the case heretofore.

The general practice is to hold the engineer responsible for the coal records and to see that he instructs his fireman along proper lines. Engineer and fireman should be made to understand that harmony in the cab is necessary in order to accomplish the desired results in fuel economy. They should examine their records on the performance sheet and be inspired by force of precept and example to make as good a showing, if not a better one, than the other engineers whose names appear on the same record. The general aim should be to proceed along the missionary plan as much as possible, imposing discipline only, as a last resort, where instructions have been wilfully disregarded.

Some roads compile data and make up an individual performance sheet, monthly, showing comparison of engineers in different classes of service on each operating division, based upon the consumption of fuel, lubricating materials and other supplies. Some consider this a good means of checking the results as between individuals, while others take the opposite view, claiming that there is a great lack of accuracy in the data secured and that when figures are not reliable the data are without value. Nevertheless, a number of the railroads are of the opinion that when the figures presented are even approximately correct, an individual performance sheet affords the best known means of checking the savings and losses made by enginemen and gives a record by which the engineers can check themselves with other men on the same division and in the same class of service, thereby spurring them on to make greater efforts to secure economies and better their showing.

There seems to be a universal sentiment opposed to a plan of giving money premiums or prizes of any sort as an incentive to engineers to improve and maintain a good fuel record. High-salaried, intelligent employees who do not make all possible economies in the operation of locomotives are doing themselves an injustice. The giving of money premiums or prizes of any character might lead the engineers into the use of unfair means, thereby introducing corruption into the ranks.

The nature of the coal in different localities, in many instances, makes a general hard and fast rule governing the size of coal used on locomotives impossible. In many regions, therefore, the size of coal used must be governed entirely by local conditions. However, the committee is of the opinion that, wherever conditions will permit, the bituminous coal should be broken into small convenient sizes, in order to secure the best results from hand or stoker firing. The best sized coal seems to be that which will pass through a 1¼ in. and over a ¾ in. screen. For anthracite burning locomotives, egg size, or that which will pass through a 2¾ in. and over a 2 in. screen, seems to be generally considered best.

The majority of replies indicate that coal run over a ¾ in.

screen will make a better record than run-of-mine coal on a basis of pounds of coal burned, but if the price is considered, run-of-mine coal containing not above 30 per cent slack will make the best record.

While skillful operation of the locomotive, both by the engineer and fireman, coupled with careful maintenance of the locomotive, play a very important part in fuel economy, it is probable that good supervision is the most valuable essential in fuel economy. A carefully developed system of education taught to the enginemen, by supervising officers of the right caliber, will result in skillful operation and co-operation between engineers and firemen. Savings of a most gratifying nature will be bound to follow.

It is certain that the following materially assist in the fuel economy campaign: Iron or wood coal gates of good design; fenders on tender platforms and inside of gangways to keep coal from falling off; movable covers over shaker bar openings, or collars around same, and prevention of overloading of tenders.

The only advantage to be gained by storage of coal is that it provides a supply of fuel during periods of strikes or shortage. All authorities agree that coal deteriorates in storage, but the loss of heat value is not very great. Coal storage is detrimental to fuel economy for the following reasons: Spontaneous combustion is liable to occur during which some of the coal is lost. Bituminous coal loses some of its efficiency due to slacking; when coal is stored on the ground, a considerable amount of dirt is apt to be picked up with it, thus reducing its value as fuel.

It has been found generally very important to instruct engineers and firemen in the principles of combustion. They should be made to understand how the gases of combustion influence the color of the fire and that unburned gases cause black smoke. This subject should be thoroughly covered in the instruction books on fuel economy, as well as in the individual and class instruction..

Conclusions.—Care should be exercised always to have fuel furnished according to a rigid specification and this should be further followed by close inspection at the minies. Proper grades of fuel should be maintained for each class of service as far as possible, in order to keep the efficiency of both the enginemen and the locomotives as high as possible.

Too much care cannot be exercised in keeping accurate coal records, especially at coaling stations. At the same time losses in fuel by overloading tenders and careless handling of locomotives at terminals should be stopped as far as possible. Fuel savings must be made by all concerned and not by the engineman alone, if the coal bills are to be reduced as much as they can be.

The boiler feed-water should be improved wherever possible, and if necessary good treating plants should be installed. The savings resulting from reduction of scale and decreased boiler maintenance will pay the cost of treating boiler feed-water where necessary. Suitably located blow-off cocks of good design are also a great aid in keeping down boiler scale.

Emphasis should be laid upon the necessity of close co-operation between engineers and firemen, and between these men and their supervising officers; strict adherence to the proper methods of operating locomotives, proper care and adjustment of lubricators to avoid damage to valves, valve seats and piston packing; and the maintenance of standard adjustments of front end arrangements, exhaust nozzles and other parts essential in producing free steaming locomotives. Definite assignment of the most suitable classes of locomotives to each division, and as far as possible, assignment of regular crews to locomotives, are great aids to fuel economy, for reasons too well known to need discussion here.

The recent successful application of powdered fuel to industrial plants points the way to large savings in locomotive fuel consumption, provided the system can be successfully adapted to this kind of service. Although there will be an increase in cost per ton due to pulverizing the coal, the expected savings should more than offset this. Some of the advantages claimed for powdered fuel are: Greater capacity of locomotive, and lightening the work of the firemen; reduced coal consumption due to more perfect combustion, and elimination of standby losses; reduction of smoke, and ease of handling.

Notwithstanding the mechanical aids to effect economy of fuel, it is a settled fact that a well organized department, invested with full charge of the fuel problems, and nothing else, will accomplish material results. Experience of many roads proves conclusively that the institution of such a department is followed by savings which abundantly justify the expense of the administrative and supervising organization.

The report is signed by: Wm. Schlafge (Erie), chairman; W. H. Fetner (B. of Ga.); D. M. Perine (Penn.); R. Quayle (C. & N. W.); S. G. Thomson (P. & R.), and D. J. Redding (P. & L. E.).

DISCUSSION

C. D. Young: I notice that the committee concludes that "care should be exercised always to have fuel furnished according to a rigid specification, and this should be further followed by close inspection at the mines." I was not aware there were very many of the roads using rigid specifications under which they were purchasing coal, if this means a specification on the B. T. U. basis, such as the Government uses in purchasing coal in quantities. Purchasing coal under specification for a railroad is a very peculiar problem. A great many roads use coal that will give them the shortest haul possible to their loading points, and therefore a specification would have to be drawn largely to suit the coal which they would want to buy, due to the shortness of the haul. We should have some more light on this subject before we conclude that the rigid specification is absolutely the best thing to have.

William Schlafge (Erie): Mr. Chairman, we have no rigid specification ourselves in that connection; our practice is to analyze the coal chemically, and we are governed by that in a large measure, and then we have our inspectors at the coal mines.

D. F. Crawford: We should use all of the coal that we can possibly use, so we will not get into the same condition with coal that we are with lumber, and that is having used all the good coal and leave nothing but the bad coal; in other words, that we use the mixture today as it comes, the absolutely unsuitable material, and I think the present purpose will be served and the future will be benefited. The tests that we have made with coal at the testing plant at Altoona, and road tests conducted with great care, indicate wide differences in the heating value of coal, but do not show that such differences affect your coal consumption proportionally in the locomotive service. I believe that instead of the use of the words "rigid specifications for coal" the whole subject can be covered by proper preparation of the coal.

I fully appreciate what a non-conducting covering means. We took one of our passenger locomotives, and for a period of three months, immediately before it went into the shop, we very carefully estimated the amount of coal used per car mile. The locomotive was then shopped. In a matter of ten days the locomotive came out of the shop with the flues reset and the boiler clean, and for a period of two or three months again a very careful estimate was made of the amount of coal used. We failed to find any difference.

Dr. Angus Sinclair: I was once running a locomotive that was very foul with scale. It was burning more coal than it ought to do, and I looked forward to a great change when the engine was taken into the shops for a new set of flues and a new firebox. I was glad to get the engine after the repairs were effected, as I believed it would be very much more efficient than it had been previously, but I never could see a bit of difference in the amount of fuel used with the foul boiler and after it was cleaned.

L. R. Pomeroy (U. S. Lighting & Heating Co.): My understanding of the use of these specifications in standard practice is not that the coal has been rejected after it has been unloaded, but it affects the price of the coal at the time settlement is made.

W. E. Dunham (C. & N. W.): I have always had bad water, and have never noticed any difference in the performance of the locomotive, whether it was dirty with scale, or not

Wm. Schlafge (Erie): It is quite certain that scale is a non-conductor, and you are going to burn more fuel with a badly scaled boiler than you are with a boiler that is free from scale. If that were not so, I do not believe we would have to limit ourselves in the thickness of tubes. We might put in half-inch tubes, instead of putting in the tubes of the present size, and get more wear out of them.

D. F. Crawford: I make no claim as to the conductivity of the scale. It was only the quantities cited by the government engineers that I took issue with.

The President: It is a well known fact that when an engine is first completed in the shops, and is brought to the roundhouse, sometimes it is complete and sometimes it is not. At the end of thirty days it has been adjusted to steam properly and to give a good coal economy. As the engine grows old the exhaust gets stronger, and the old engine will steam well and not burn very much fuel.

Geo. H. Baker, (Railway Educational Ass'n.): There are one or two things not covered in this report which I think ought to receive attention, the ash-pans, the area for air admission to the ash-pans. The more air you get in the ash-pans, the larger you can make your nozzles and the larger draft you will have under the fire, the less sparks you throw out your stack, and the less back pressure you have on the cylinders.

(The report was accepted and the committee made a standing committee.)

ROAD TESTS OF SCHMIDT SUPERHEATER AND BRICK ARCH

BY H. W. CODDINGTON, ENGINEER OF TESTS, NORFOLK & WESTERN, ROANOKE, VA.

In the summer of 1913, there was conducted upon the Norfolk & Western a series of tests for the purpose of determining the relative performance of the superheated and non-superheated locomotives in the same service. In connection with th superheated test, there also was featured the subject of the brick arch.

Both locomotives, preparatory to the tests, were brought in to the shops and given a thorough overhauling, after which they were given some preliminary service in order to break them in before introducing them into the test service. The general dimensions of the locomotives are as follows:

	Eng. No. 1160	*Eng. No. 1136*
Type of locomotive	4-8-0	4-8-0
Total weight (3 gages of water)	262,000	263,000
Total weight stoker	....	5,220
Total weight on drivers (Workg. Ord.)	222,000	228,000
Cylinders (normal)	24 by 30 in.	24 by 30 in.
Cylinders (actual)	R 24—11-128	R 21—1-16 in.
	L 24—3-32 in.	L 24—1-32 in.
Diameter of drivers (actual)	55—35-64 in.	54—9-32 in.
Heating surface (firebox)	179 sq. ft.	179 sq. ft.
Heating surface (arch tubes)	....	13
Heating surface (superheater tubes)	690	....
Heating surface in tubes (small)	2,103	4,281
Heating surface in tubes (Large superheater)	905	....
Heating surface in firebox (Inc. arch tubes)	192	192
Total heating surface (without arch)	3,877	4,473
Total heating surface (with arch)	3,890	....
Grate area	45	45
Boiler pressure (normal)	200	200
Valves—type	15 in. Pis.	15 in. Pis.
Valves—motion	Baker	Walsch't
Firebox—type	Wide	Wide
No. of tubes (small)	217	386
No. of tubes (large for superheater)	34	....
Outside diameter of tubes (small)	2	2¼
Outside diameter of tubes (superheater)	5½	....
Length of tubes	18 ft. 6 in.	18 ft. 10 in.

The district selected for making these locomotive tests is between Roanoke and Christiansburg, Va., a district 29 miles long, 17 miles of which is comparatively level or undulating grade, where the engine can be observed under what is termed moderately high-speed conditions. The remaining 12 miles is on an almost uniform grade of 1.32 per cent. up Allegheny mountain from Elliston to Christiansburg. In this particular district the engine is worked under maximum conditions, the amount of tonnage hauled being governed by what can be handled successfully on the 12 miles of heavy grade. In this way, the operation was under most ideal conditions as far as the delays were concerned.

The tanks were carefully calibrated in increments of 400 lb. of water and the coal, Pocahontas run-of-mine, was sacked in 100 lb. quantities. The samples of the smoke box gases were obtained by displacement in a tank of 1,900 cu. cm. The samples were taken from the front of the smoke box about 12 in. beneath the center of the door and inside the netting. The injector overflow was caught and measured and the number of pump strokes counted to determine its consumption. The pop discharge was also recorded and a ⅝ in. nozzle was used on the blower. The blower was always operated to its full capacity, and the total time the blower was in operation, and the average steam pressure recorded.

In determining the temperature of the flue gases in the smoke box, we employed Hoskins pyrometer elements, the results obtained from engine No. 1160 were the only ones accepted as being correct. A Peabody throttling calorimeter was connected to the live steam passage in the cylinder saddle on the non-superheated locomotive No. 1136. On the superheated locomotive No. 1160 the calorimeter was connected to the steam dome. The notches on the reverse bar quadrant were numbered counting from the center. The throttle opening was determined by removing the dome cap when the locomotive was in the shops.

The Westinghouse Air Brake Company's Dynamometer Car No. 2, which was used in connection with these tests, made the establishment of the draw-bar pull and dynamometer horsepower possible. The following records were established on the chart: Draw-bar pull; boiler pressure; operation of steam indicators; coal delivered to the fireman; position of reverse bar; position of throttle; speed in miles per hour; strokes of both air compressors (in single strokes and groups of 50); location of mile posts and stations; distance in increments of 1-40, 1-10 and 1 mile; and time in increments of five and thirty seconds.

The tabulated data is presented in three groups, *A*, *B* and *C*, which may be identified as follows:

Group *A* represents the performance of class M-2 locomotive No. 1160 equipped with Schmidt superheater, hand-fired.

Group *B* represents the performance of class M-2 locomotive No. 1160 equipped with Schmidt superheater and brick arch, hand-fired.

Group *C* represents the performance of class M-2 locomotive No. 1136 equipped with brick arch; hand-fired (no superheater).

TABLE I.—GENERAL PERFORMANCE.

Group	Run No	Date	No De-lays	Duration Test Hrs Total	Delay	Rn'g	Miles Run	* Speed M P H	Cars in Train	Tonnage Car	Eng. & Tend	Boiler Press Avg
	26	27	28	29	30	31	32	33	34	35	36	37
A	7	7-18-13	2	1.87	.30	1.569	29.71	18.92	17	1193.5	203.6	198.3
A	9	7-21-13	1	1.70	.18	1.526	29.71	19.55	17	1193.5	203.8	200.3
A	10	7-22-13	6	1.96	.27	1.686	29.71	17.58	17	1193.5	202.9	199.9
A	11	7-23-13	3	1.79	.21	1.579	29.71	18.80	17	1193.5	202.9	199.7
A	16	7-29-13	2	1.79	.18	1.614	29.71	18.40	17	1202.5	203.6	197.4
	Avg.		3	1.82	.23	1.595	29.71	18.65	17	1195.3	203.4	199.1
B	17	8- 5-13	2	1.81	.24	1.568	29.71	18.95	17	1202.5	201 9	199.1
B	18	8- 6-13	2	1.83	.30	1.525	29.71	19.48	17	1202.5	203.2	199.7
B	19	8- 7-13	1	1.87	.24	1.633	29 71	18.19	17	1202.5	203.3	199.5
B	22	8-12-13	2	1.77	.27	1.497	29.71	19.85	17	1193.5	203.1	199.0
B	23	8-13-13	1	1.73	.22	1.510	29.71	19.67	17	1193.5	202.9	198.6
	Avg.		1.6	1.80	.25	1.547	29.71	19.23	17	1198.9	202.9	199.2
C	6	5-10-13	3	3.85	1.65	2.20	30.98	14.08	15	1029.3	203.5	191.2
C	8	5-14-13	7	3.89	1.83	2.06	30.86	14.98	15	1029.3	203.9	193.7
C	9	5-15-13	6	3.02	.96	2.06	30.21	14.66	15	1029.3	204.4	189.2
C	10	5-16-13	7	3.67	1.60	2.07	29.96	14.47	15	1029.3	202.6	194.1
C	12	5-19-13	3	2.33	.48	1.84	29.71	16.15	15	1029.3	203.3	192.3
C	15	5-24-13	7	2.69	.59	2.11	30.21	14.31	15	1045.7	203.4	195.5
	Avg.		5.5	3.24	1.18	2.06	30.32	14.78	15	1032.0	203.5	192.7

(*) From time and distance.

Referring to the data shown on Table I, notice the conditions as to the number of cars and tonnage hauled, items 34 and 35, were the same for Groups *A* and *B*, while in *C* it was 2 cars less. In order to work the superheated locomotive to its maximum capacity and yet restrict it to approximately the same speed conditions as were obtained on the non-superheated locomotive, it was necessary to add two additional cars to the train increasing the total tonnage of the train 16.1 per cent. A review of the advantages incident to the superheater shows that the superheated locomotive hauled 13-3 per cent. more cars or 16.1 per cent. more tonnage at an increase of 30 per cent. higher speed, an increased boiler pressure of 3.3 per cent., and as will be observed in Table II, with a decreased coal consumption per M ton miles of 26.8 per cent.

The most noticeable difference which may be attributed to the influence of the brick arch is the reduction in coal consumption per M Ton Car Miles, item No. 38, Table II, in which a 5 per cent. decrease is observed.

TABLE II.—FUEL RATE OF COMBUSTION.

Group	Run No.	Fuel in Pounds. Total Fired.	Running Time.	Per Hour. Total Time.	Per Hour. Running Time.	Rate of Combustion per Hr., Run. Time. Sq. Ft. Gr.Area.	Sq. Ft. Htg. Surface.	M Ton Car Miles.	Pounds Coal, M Ton Car Miles Excluding Delays.
	25	40	41	42	43	44	45	37	38
A	7	9 600	9 500	5 134	6 055	134.6	1.56	35.46	267.9
A	9	9 200	9 100	5 412	5 963	132.5	1.54	35.46	256.6
A	10	9 000	8 800	4 592	5 219	116.0	1.35	35.46	248.2
A	11	9 200	9 000	5 139	5 700	126.7	1.47	35.46	253.8
A	16	9 300	9 100	5 195	5 638	125.2	1.45	35.73	256.6
	Avg.	9 260	9 100	5 094	5 715	127.0	1.47	35.51	256.6
B	17	8 700	8 600	4 815	5 484	121.8	1.40	35.73	240.7
B	18	8 600	8 400	4 699	5 508	122.4	1.41	35.73	235.1
B	19	8 500	8 400	4 533	5 145	114.3	1.32	35.73	235.1
B	22	9 300	9 100	5 260	6 078	135.0	1.56	35.46	256.6
B	23	9 100	1 000	5 266	5 960	132.4	1.53	35.46	238.8
	Avg.	8 840	8 700	4 915	5 635	125.2	1.44	35.62	244.3
C	6	11 500	10 700	2 987	4 863	108.0	1.09	31.89	335.5
C	8	11 200	10 400	2 879	5 048	112.2	1.13	31.76	327.4
C	9	10 200	9 900	3 377	4 806	106.8	1.08	31.09	318.4
C	10	10 900	10 500	2 970	5 072	112.7	1.14	30.84	340.4
C	12	10 900	10 700	4 678	5 815	129.2	1.30	30.58	349.9
C	15	10 600	10 500	3 940	4 976	110.6	1.11	31.59	332.4
	Avg.	10 883	10 449	3 472	5 097	113.2	1.14	31.29	334.4

Comparing the results of Groups *B* and *C*, notice that the total coal fired, running time, is 16.7 per cent. less in Group *B*. The difference in total coal consumption is not the best basis for comparison as the increased tonnage handled in the tests of Group *B* is not taken into account, therefore, item No. 38 should be employed in the comparison of fuel consumption. By referring to item No. 38, "Pounds of Coal per M ton miles,"

it is noticed that this item is remarkably lower for the superheated locomotive, which difference amounts to 26.8 per cent. For Group *B*, the rate of combustion per square foot of grate area per hour was 125.2, while for Group *C* the same item was 113.2.

In calling attention to Table III, it will not be necessary to compare Groups *A* and *B*, except in a general way to notice that the

TABLE III.—WATER AND STEAM.

Group	Run No.	Pounds of Water—Total: Supp to Inject	Pounds of Water—Total: Inject O'flow	Pounds of Water—Total: Suppl'd to Boiler	Temp. of Feed Water	Consumption Steam By: Pumps	Consumption Steam By: Calorm.	Consumption Steam By: Blower	Consumption Steam By: Pop Dis-charge
	26	51	52	53	54	55	56	57	58
	7	50,212	486	49,726	73.0	2,059	421		2,591
	9	46,862	324	46,538	71.5	1,811	410		2,281
A	10	51,462	301	51,161	66.5	2,232	455		1,387
	11	50,062	378	49,784	68.2	2,039	425		1,971
	16	47,900	405	47,495	73.6	1,953	430		912
	Avg.	49,300	379	48,941	70.6	2,017	428		1,828
	17	50,500	468	50,032	72.5	2,430	422		1,752
	18	49,825	369	49,456	69.7	2,762	410		2,354
B	19	48,800	333	48,467	70.5	2,233	438		2,281
	22	51,287	378	50,909	71.5	2,214	403		2,281
	23	49,587	342	49,245	66.7	2,232	404		4,456
	Avg.	50,000	378	49,622	70.2	2,374	415		1,825
	6	78,000	1,089	76,811	65.0	4,325	472	1,912	1,712
	8	78,900	729	78,171	64.0	4,229	455	354	1,712
	9	73,000	1,026	71,974	65.2	3,417	425	618	1,712
C	10	77,212	801	76,411	64.5	4,141	449	701	1,712
	12	71,187	423	70,764	67.0	2,837	387	428	
	15	73,812	576	73,236	65.2	2,677	474	533	548
	Avg.	75,340	774	74,561	65.1	3,604	443	758	1,479

conditions of general service were almost identical as indicated by the water and steam consumption, but comparison between Groups *B* and *C* will justify closer analysis. Keeping in mind the increased performance of the locomotive in Group *B* as has already been recognized, it is particularly interesting to notice an accompanying decreased water consumption. It is also to be noticed, in Group *B*, that no steam is charged to the operation of the blower which indicates how freely the superheated locomotive steamed under the subjected conditions. In comparison with this, notice that an average of 758 lb. of steam per trip was used by the blower in Group *C* or upon the non-superheated locomotive.

The equivalent evaporation per pound of dry coal is considered on the basis of the boiler exclusive of superheater, the

TABLE IV.—EQUIVALENT EVAPORATION PER POUND OF COAL AND SQUARE FOOT HEATING SURFACE.

Group	Run No.	Equivalent Evaporation, Per Pound of Dry Coal: Boiler Excluding Super-heater	Per Pound of Dry Coal: Super-heater Alone	Per Pound of Dry Coal: Boiler Includ'g Super-heater	Per Hour, Per Sq. Ft. of Heating Surface: Boiler Excluding Super-heater	Per Hour, Per Sq. Ft. of Heating Surface: Super-heater Alone	Per Hour, Per Sq. Ft. of Heating Surface: Boiler Including Super-heater	Ratio of Equiv. Evap. In Suph. to Boiler Per Sq. Ft. of He'g Sur
	26	125	126	71	127	128	73	129
	7	6.21	.57	6.78	11.70	6.47	10.50	.553
	9	6.10	.57	6.67	11.29	6.38	10.16	.565
A	10	6.98	.68	7.66	11.26	6.49	10.16	.576
	11	6.31	.60	6.91	11.62	6.36	10.09	.547
	16	6.17	.61	6.78	10.86	6.37	9.81	.587
	Avg.	6.35	.61	6.96	11.35	6.41	10.14	.566
	17	6.95	.66	7.61	11.80	6.72	10.60	.569
	18	7.05	.69	7.74	12.00	6.97	10.83	.581
B	19	6.91	.66	7.57	11.09	6.29	9.88	5.67
	22	6.70	.68	7.38	12.59	7.54	11.39	.599
	23	6.60	.66	7.26	12.12	7.19	10.92	.593
	Avg.	6.84	.67	7.51	11.92	6.94	10.72	.582
	6			8.09			9.43	
	8			8.44			10.26	
	9			8.56			9.44	
C	10			8.54			9.98	
	12			7.86			10.38	
	15			8.42			9.39	
	Avg.			8.32			9.81	

superheater alone and the combined performance of both. A comparison of items Nos. 125 and 126 in Table IV is presented here to illustrate the equivalent value of the superheater considered from the standpoint of an evaporative unit. Item No. 73 gives the equivalent evaporation per square foot of heating surface per hour, including both boiler and superheater from which the average value for the superheated locomotive is 10.72 while for the non-superheated locomotive is 9.81.

In Table V the temperature of the smoke-box gases for Group *C* should not be considered absolutely correct, for the

TABLE V.—TEMPERATURE AND ANALYSES OF SMOKE BOX GASES.

Group	Run No.	Temperature of Escaping Gases: Front of Smoke Box	Temperature of Escaping Gases: Back of Baffle Plate	Smoke Box Gas Analyses: Carbon Dioxide Co_2	Smoke Box Gas Analyses: Carbon Monoxide Co	Smoke Box Gas Analyses: Oxygen	Smoke Box Gas Analyses: Nitrogen N
	26	49	50	121	122	123	124
	7	617	712	10.6	1.2	5.0	83.2
	9	612	739	11.0	1.6	4.4	83.0
A	10	574	720	9.0	1.2	7.2	82.6
	11	634	723	10.4	1.2	4.2	84.2
	16	579	709	10.4	.6	4.4	84.6
	Avg.	603	722	10.3	1.2	5.0	83.5
	17	595	644	7.0	1.4	8.0	83.6
	18	614	681	8.2	.4	7.6	83.8
B	19	620	676	5.4	1.6	11.4	81.6
	22	604	680	9.4	.8	7.2	82.6
	23	618	682	9.6	.6	9.8	80.0
	Avg.	610	673	7.9	1.0	8.8	82.3
	6	559	685	5.0	0.2	7.2	87.6
	8	583	715	10.6	trace	7.8	81.6
C	9	560	708	8.8	0.4	7.6	83.2
	10	585	715	7.8	0.2	8.4	83.6
	12	594	688	6.4	0.8	10.2	82.6
	13	643	740	10.8	1.0	6.6	81.6
	Avg.	587	708	8.2	0.4	8.0	83.4

pyrometers indicated falsely sometime during this group of tests, but the temperature for Groups *A* and *B* may be considered as correct.

In Table VI is some interesting information relating particularly to the performance of the superheater. In the pressure

TABLE VI.—PRESSURES AND TEMPERATURES.

Group	Run No.	Pressures: Boiler	Pressures: Atmosp	Pressures: Return Chambr Superht	Pressures: Steam Chest	Pressures: Exhaust	Temperatures: Steam Chest	Temperatures: Degrees Supht Steam Chest	Temperatures: Degrees Supht Exhaust	Temperatures: Atmospheric
	26	39	77	130	131	132	133	134	135	76
	7	198.3	14.18	190.9	187.5	5.50	602.6	220.2	68.9	89.0
	9	200.3	14.01	191.9	187.1	4.95	609.5	227.3	69.9	78.7
A	10	199.9	14.12	191.6	188.7	5.15	616.8	233.9	80.1	78.7
	11	199.7	14.05	191.5	187.0	5.55	614.7	232.5	76.2	80.0
	16	197.4	14.05	190.1	185.3	3.93	622.5	241.0	82.2	91.0
	Avg.	199.1	14.08	191.2	187.1	5.01	613.2	231.0	75.5	83.5
	17	199.1	14.03	190.7	186.9	5.08	624.8	242.5	82.3	79.3
	18	199.7	14.02	192.3	188.2	4.98	629.4	246.6	84.2	80.3
	19	199.5	14.01	192.2	188.8	4.33	627.2	244.2	85.1	73.3
B	22	199.0	14.07	188.6	186.2	6.00	636.9	254.9	91.4	66.3
	23	198.6	14.03	188.5	184.0	6.35	634.3	253.3	85.4	76.3
	Avg.	199.2	14.03	190.5	186.8	5.35	630.5	248.3	85.7	75.1
	6	191.2	14.01							65.0
	8	193.7	13.96							73.3
C	9	189.2	14.05							71.6
	10	194.1	14.08							77.0
	12	192.3	14.06							77.6
	15	195.5	13.98							61.3
	Avg.	192.7	14.02							71.0

TABLE VII.—BOILER HORSE POWER AND EFFICIENCIES.

Group	Run No.	Boiler Horse Power Hour: Boiler Exclu Super h'r	Boiler Horse Power Hour: Super h'r Alone	Boiler Horse Power Hour: Boiler Includ Super	Boiler Incl Super hr: Per Sq Ft Heeting Surface	Boiler Incl Super hr: Per Sq Ft Grate Area	Boiler Efficiencies: Boiler Exclu Super	Boiler Efficiencies: Super Alone	Boiler Efficiencies: Boiler Includ Super h'r
	26	136	137	113	138	139	140	141	74
	7	1080.7	99.2	1179.9	.304	26.19	44.3	3.6	47.9
	9	1043.9	97.5	1141.4	.294	25.33	43.5	3.9	47.4
A	10	1040.1	101.3	1141.4	.294	25.33	49.5	4.6	54.1
	11	1035.5	97.9	1133.4	.292	25.16	43.5	4.1	47.6
	16	1003.3	99.2	1102.5	.284	24.47	42.9	4.2	47.1
	Avg.	1040.7	99.0	1139.7	.294	25.30	44.7	4.1	48.8
	17	1095.1	104.0	1199.1	.307	26.54	49.0	4.5	53.5
	18	1112.7	108.9	1221.6	.314	27.14	49.1	4.7	53.8
B	19	1019.5	97.3	1116.8	.286	24.72	48.9	4.6	53.5
	22	1167.5	118.5	1286.0	.330	28.52	46.6	4.6	51.2
	23	1124.1	112.6	1236.7	.316	27.31	45.9	4.5	50.4
	Avg.	1103.8	-08.3	1212.0	.311	26.85	47.9	4.6	51.5
	6			1134.0	.254	25.20			58.9
	8			1231.5	.376	27.37			59.3
	9			1184.5	.266	26.32			62.1
C	10			1241.1	.278	27.58			62.7
	12			1316.6	.295	29.26			55.5
	15			1202.0	.270	26.71			60.7
	Avg.			1218.3	.273	27.07			59.9

determinations it is of interest to note, in Group *B*, that with an average boiler pressure of 199.2 lb. per sq. in., item No. 39, there was observed an average pressure of 190.5 lb., item No. 130, in the return chamber of the superheater, while in the cylinder saddle passage to the steam chest, the average pressure was 186.8 lb. From these observations, it is observed that the average drop in pressure from the boiler proper to the steam chest is 12.4 lb. Attention has been called to the average pressure in steam chest of 186.8 lb., item No. 133 gives the average temperature of the steam at this same point which is 630.5 deg. F.

TABLE VIII.—POUNDS OF STEAM THRU CYLINDERS PER THOUSAND TON-MILES

Group	Run No	M Ton Car Miles	M Ton Train Miles	Steam thru Cylinders—Pounds			B t u Thru Cyl. Per M T Train Miles
				Per M Ton Car Miles	Per M Ton Train Miles	Total	
	26	37	82	83	84	85	86
	7	35.46	41.51	1259	1076	44,655	1,419,599
	9	35.46	41.51	1185	1013	42,036	1,340,320
A	10	35.46	41.49	1328	1135	47,087	1,505,407
	11	35.46	41.49	1279	1093	45,349	1,448,881
	16	35.46	41.51	1246	1065	44,200	1,415,917
	Avg.	35,46	41.50	1259	1076	44,665	1,426,025
	17	35.73	41.72	1271	1089	45,428	1,406,901
	18	35.73	41.76	1229	1052	43,930	1,364,412
B	19	35.73	41.77	1218	1042	43,515	1,349,234
	22	35.46	41.49	1333	1139	47.261	1,480,920
	23	35.46	41.49	1301	1112	46,153	1,449,592
	Avg.	35.62	41.65	1270	1087	45,257	1,410,213
	6	31.89	38.19	2144	1790	68,389	2,146,264
	8	31.76	38.05	2248	1877	71,421	2,251,282
	9	31.09	37.27	2084	1739	64,802	2,084,757
C	10	30 84	36.91	2250	1880	69,408	2,254,906
	12	30.58	36.62	2195	1833	57,122	2,198,082
	15	31.59	37.74	2184	1828	69,004	2,192,774
	Avg.	31.29	37.46	2184	1824	68,356	2,188,011

The temperature of the steam at the observed pressure corresponds to 248.3 deg. superheat. The exhaust pressure as observed in one of the cylinder exhaust passages was 5.35 lb. per sq. in., item No. 132. Temperature determinations of the steam were also made in the exhaust passage, from which it was observed, item No. 135, that the steam was being exhausted in an average temperature of 85.7 deg. superheat.

The boiler horse-power developed and boiler efficiencies have been worked up both separately and collectively for boiler and superheater on the superheated locomotive in Table VII. Beginning with item No. 136, Group *B*, notice an average boiler horse-power of 1103.8 attributed to the boiler exclusive of superheater. Item No. 137 shows the proportion of the boiler performance which may be attributed to the superheater alone which amounts to 108.3 boiler horse-power. The total of these two results, item No. 113, is 1212 boiler horse-power, and is almost identical with the results obtained from the non-superheated locomotive, Group *C*. The reason for the boiler horse-power being so nearly equal when the total water supplied the boiler was so different is on account of the decreased running time increasing the rate of the boiler performance with the superheated locomotive and the additional heat units taken up by the steam in the process of superheating. The average boiler efficiency for the superheated locomotive exclusive of the superheater is 47.9 per cent. The proportion of the total boiler efficiency credited to the superheater is 4.6 per cent. Item No. 74 gives the total boiler efficiency, including the superheater, or 52.5 per cent., which is slightly lower than the 59.9 per cent., the average boiler efficiency of the non-superheater locomotive, Group *C*. This difference in boiler efficiency being 12.3 per cent. favorable to the non-superheated steam upon the locomotive as a unit.

TABLE IX.—INITIAL AND LEAST BACK PRESSURES.
Average Results.

Group	Run No.	Total Performance Roanoke to Christiansburg			High Speed Performance Roanoke to Elliston			Slow Speed Performanc Elliston to Christiansburg		
		Pressures Average		* Speed in M PH	Pressures Average		* Speed in M PH	Pressures Average		* Speed in M PH
		Initial	L Back		Initial	L Back		Initial	L Back	
	26	96	95	97	96a	95a	97a	96b	95b	97b
	7	179.2	7.5	18.90	170.8	7.5	26.62	184.8	7.6	13.80
	9	178.6	7.2	19.60	168.2	7.8	29.60	185.5	6.9	13.44
A	10	175.6	7.6	19.10	161.7	8.4	27.25	184.8	7.1	13.70
	11	179.8	7.6	19.45	169.0	7.8	28.40	186.6	7.5	13.80
	16	171.9	6.0	19.29	152.9	6.9	28.67	184.6	5.4	13.04
	Avg.	177.0	7.2	19.27	164.5	7.7	28.11	185.3	6.9	13.56
	17	183.5	7.4	19.56	179.6	7.8	29.00	186.2	7.2	13.30
	18	187.4	7.3	19.45	181.2	8.3	29.20	184.0	6.6	12.90
B	19	182.9	6.7	18.40	179.1	6.8	27.30	185.5	6 6	12.80
	22	186.3	9.1	20.00	185.3	9.6	29.80	187.0	8.8	13.90
	23	184.6	8.3	20.90	185.5	10.3	33.80	184.0	7 0	12.90
	Avg.	184.9	7.8	19.66	182.1	8.6	29.80	185.3	7.2	13.20
	6	149 1	8.0	14.60	107.1	10.5	21.30	177.3	6.3	10.13
	8	151.7	9.8	15.35	113.6	11.7	20.83	177.1	8.5	11.70
C	9	145.4	10.0	15.52	106.1	11.8	21.77	170.5	8.7	11.35
	10	150 1	10.8	15.13	115.0	11.9	19.83	173.5	10 1	11.99
	12	143.6	9.3	15.95	100.8	8.9	21.70	172 2	9.6	12.10
	15	150 2	9.4	15.09	107.0	10.7	20.44	179.4	8 4	11.19
	Avg.	148.3	9.5	15.27	108.3	10.9	20.98	175.0	8.6	11.41

(*) Speed of train when indicators were taken.

The observed decrease in steam consumption in Table VIII on the superheated locomotive may in a measure be attributed to the manner in which the locomotive was operated between Roanoke and Elliston, viz.: with full throttle and short cut-off. The superheated condition of the steam made this method of operation possible, which could not be followed with the non-superheated locomotive on account of the incapacity to maintain the desired boiler pressure. The B. t. u. through cylinders, item No. 86, also indicates the performance peculiar to the superheated conditions. Comparing the average results of this item for Groups *B* and *C*, a difference of 35.5 per cent. favorable to the superheated locomotive is noticed.

In a discussion of initial and least back pressure results obtained from the indicator diagrams, the averages on Table IX are best for this consideration. The average results are so arranged that they may be reviewed for the trip as a whole, the high-speed conditions only, or the low-speed performance alone. In the total performance, Roanoke to Christiansburg, by comparing the average results for the different groups under items 95 and 96, little variation is observed between Groups *A* and *B*, but in Group *C*, the initial pressure is considerably lower for the non-superheated locomotive. This difference can be explained as being influenced by the different manner in which the locomotive was operated, especially in the high-speed performance between Roanoke and Elliston. With the superheated locomotive, the locomotive was operated under full throttle throughout the entire test, and the reverse bar worked as far back as possible. This, of course, would influence high initial pressure results.

TABLE X.—INDICATED HORSE POWER.
Relation to Fuel, Heating Surface and Grate Area.

Group	Rnn No.	Total Run Roanoke to Christ'nsbg			High Speed Roanoke to Elliston			Slow Speed Elliston to Christ'nsbg		
		Indicated Horse Power								
		Sq. Ft. Heating Surface (Total)	Sq.Ft. Grate Area	D'yCoal IHP Per Hr Pound	Sq. Ft. Heating Surface	Sq.Ft. Grate Area	D'yCoal IHP Per Hr. Pounds	Sq. Ft. Heating Surface	Sq.Ft. Grate Area	D'yCoal IHP Per Hr Pounds
	26	104	105	106	104a	105a	106a	104b	105b	106b
	7	.409	35.3	3.77	.406	35.0	3.47	.412	35.4	4.09
	9	.416	35.8	3.67	.425	36.6	3.16	.409	35.3	4.07
A	10	.423	36.4	3.14	.436	37.5	2.47	.414	35.6	3.82
	11	.413	35.6	3.54	.402	34.6	3.10	.421	36.2	3.99
	16	.402	34.6	3.61	.407	35.0	3.18	.397	34.2	4.03
	Avg.	.413	35.5	3.55	.415	35.7	3.08	.411	35.3	4.00
	17	.410	35.4	3.41	.417	36 0	2.92	.405	35.0	3.82
	18	.404	34.9	3.46	.417	36.0	3.68	.396	34.2	3.49
B	19	.390	33.7	3.36	.384	33.2	3.14	.393	34.0	3.57
	22	.441	38.2	3.50	.464	40.2	2.94	.427	36.9	4.03
	23	.424	36.7	3.56	.474	40.9	2.99	.394	34.0	4.03
	Avg.	.414	35.8	3.46	.431	37.3	3.13	.403	34.8	3.79
	6	.245	24.4	4.40	.235	23.3	4.66	.253	25.1	4.24
	8	.273	27.1	4.11	.255	25.3	4.07	.285	28.2	4.15
C	9	.261	25.8	4.10	.247	24.5	3.93	.270	26.7	4.25
	10	.276	27.3	4.10	.255	25.3	3.89	.290	28.7	4.30
	12	.273	27.0	4.73	.243	24.1	4.96	.292	29.0	4.63
	15	.261	25.9	4.24	.239	23.7	4.26	.277	27.4	4.30
	Avg.	.265	26.2	4.28	.246	24 4	4.29	.278	27.5	4.30

Table X is prepared for the purpose of considering the relation of indicated horse-power to fuel consumption, heating surface and grate area as influenced by the different conditions of service. Items 104, 105 and 106 show these relations as observed for the total run. The ratio of power developed to the coal consumed is indicated in item 106. Referring to the results of Groups *B* and *C*, notice the dry coal consumed per indicated horse-power per hour is 3.46 lb. for Group *B*, and 4.28 for Group *C*, resulting in a decrease of 19.1 per cent. coal consumption per unit of power developed with the superheated locomotive.

Reviewing the differences in indicated horse-power developed and coal consumption per indicated horse-power, the following

percentages favorable to the superheated locomotive are particularly pertinent:

PERCENTAGES IN FAVOR OF SUPERHEATED LOCOMOTIVE.

	Increased Indicated Horse-power Developed.	Decreased Coal per Indicated Horse-power Developed.
Entire Run	36.1%	19.1%
High-speed Performance	53.0%	27.0%
Low-speed Performance	26.4%	11.8%

From the above relation of values, the greatest difference in both indicated horse-power developed and coal consumed per unit of power is noticed accompanying high-speed operation.

An increase in the indicated horse-power of 36.1 per cent. has been observed in the performance of the superheated locomotive considering the entire run. In Table XI, item 110, the drawbar horse-power is presented, and by comparing the average results of Groups *B* and *C*, a difference of 40.3 per cent. favorable to Group *B* is noticed. This is slightly in advance of the difference in indicated horse-power, but the difference is expected to appear in the direction as the superheated locomotive was handling more tonnage than the non-superheated locomotive.

TABLE XI.—INDICATED AND DRAW BAR HORSE POWER

Group	Run No.	Indicated Horse Power Right Side	Indicated Horse Power Left Side	Indicated Horse Power Total	Draw Bar H P	Draw Bar Pull In Pounds	Steam Per I H P Hour In Pounds Actual	Steam Per I H P Hour In Pounds Equiv	B t u In Steam Per Draw Bar Horse Power Per Hour
	26	108	109	103	110	112	114	115	116
A	7	809.4	784.3	1593.7	1410.6	31,661	19.9	25.6	25,143
	9	821.1	788.2	1609.3	1373.5	30,864	19.0	24.5	25,101
	10	837.3	801.4	1638.7	1409.8	31,156	18.5	24.1	24,958
	11	820.3	780.3	1600.6	1416.1	32,234	18.9	24.5	25,503
	16	789.4	765.9	1555.3	1376.9	31,259	18.9	24.5	24,976
	Avg.	815.2	784.0	1599.5	1397.2	31,435	19.0	24.6	25,136
B	17	818.2	776.0	1594.0	1381.0	30,948	20.0	25.9	26,389
	18	800.7	770.7	1571.5	1357.4	30,728	20.6	26.8	26,798
	9	765 6	749.9	1515.6	1359.4	32,367	19.6	25.4	24,713
	22	881.4	836.1	1717.5	1557 3	33,616	19 8	25.8	25,644
	23	849.6	796.7	1650.9	1395.8	30,506	19.8	25.8	27,787
	Avg.	823.1	785.9	1609.9	1410.2	31,633	20 0	25.9	26,266
C	6	571.7	527.9	1099.6	890.2	27,320	28.3	35.7	42,575
	8	621.2	596.5	1217.8	1042 4	28,626	28.5	34.9	39,320
	9	592.6	573.1	1165.7	988.5	27,474	27.0	35.1	40,100
	10	617.7	607.8	1225.5	1064.8	29,287	27.4	34 8	39,215
	12	611.4	605.2	1216.5	1046.8	28,175	29.9	37.1	41.970
	15	588.9	582.6	1171.5	994.4	28,317	27.9	35.6	40,525
	Avg.	600.5	582.2	1182.8	1004.5	28,200	28.2	35.5	40,617

Comparing the mechanical efficiencies in Table XII, item 117, very little difference is observed between any of the three groups, the chief difference is between Groups *B* and *C* in which Group *B* is 3 pr cent. higher. The difference in thermal efficiency upon indicated horse-power basis is 23.7 per cent. for the superheated locomotive and upon the drawbar horse-power basis is 27.4 per cent. higher.

TABLE XII.—EFFICIENCIES.
Total Run—Roanoke to Christiansburg.

Group	Nun No	Draw Bar Horse Power	I H P	Mechanical Efficiencies Per Cent.	H P Equiv of Btu Applied Per Hour	Thermal Efficiencies I H P Per Cent	Thermal Efficiencies D B H P Per Cent	Boiler H P (Run'g Time) Inc. Super-h tr	* Speed In M H P
	26	110	103	117	118	119	120	113	97
A	7	1410.6	1586 1	88.94	32,262	4.92	4.37	1179.9	10.90
	9	1372.9	1612.4	85.14	31.596	5.10	4.34	1141.4	19.60
	10	1409.8	1638.8	86 03	27,654	5.93	5.10	1141.4	19.10
	11	1416.1	1601.3	88.43	31,311	5.11	4.52	1133.4	19.45
	16	1376 9	1555.2	88 53	30,749	5.06	4.48	1102.5	10.29
	Avg.	1397.3	1598.8	87.41	30,714	5.22	4.56	1139.7	19.27
B	17	1381.0	1594.2	86.63	29,397	5.42	4.70	1190.1	19 56
	18	1357.4	1571.5	86.28	29,802	5.27	4.55	1221.6	19.45
	19	1359.4	1515.6	89.69	27,428	5.53	4.96	1116.8	18.40
	22	1557.2	1717.5	90.66	32,975	5.21	4.72	1286.0	20.00
	23	1395.8	1650.9	84.55	32,247	6.12	4.33	1236.7	20.90
	Avg.	1410.2	1609.9	87.58	30,370	5.31	4.65	1212.0	19.66
C	6	890.2	1099.6	81.14	25,988	422	3.43	11.34.0	14.60
	8	1042.4	1217.8	85.90	27.975	4.35	3.73	1231.5	15.35
	9	988.5	1165.7	84.80	25,713	4.52	3.84	1184.5	15.52
	10	1064.8	1225.5	86.54	26,719	4.6	4.0	1241.1	15.13
	12	1046 8	1216.5	86.05	32,229	3.77	3.24	1316.6	15.95
	15	994.4	1171.5	85.46	26,972	4.31	3.69	1202.0	15.09
	Avg.	1004.5	1182.8	84.98	27,599	4.29	3.65	1218.2	15.27

(*) Speed of train when indicators were taken.

In Table XIII is a list of twenty-three items which are of particular interest in the comparison of superheated and non-superheated locomotives. The values for these items are given for both the superheated and non-superheated performance and at the extreme right of the sheet is shown the per cent. of difference between the performance of the two. The differences preceded by a plus sign (+) indicate the items which have shown a difference favorable to the superheated locomotive. Those preceded by the minus sign (—) represent differences favorable to the non-superheated locomotive.

TABLE XIII.—SUMMATION OF SIGNIFICANT DIFFERENCES BETWEEN THE PERFORMANCE OF SUPERHEATED AND NON-SUPERHEATED LOCOMOTIVES.

Item		Eng 1160 Superheated	Eng 1136 Non-superheated	** Per Cent Difference
39	Boiler pressure	199.2	192.7	+ 3.3
35	Tonnage hauled	1198.9	1032.0	+16.1
33	Speed, m. p. h.	19.23	14.78	+30.1
38	Coal per m. t. mile	244.3	334.0	+26.8
53	Water supplied tob oiler	49,622	74,551	+33.4
71	Equivalent evaporation per lb. of dry coal	7.51	8 32	— 9.7
74	Boiler efficiency	52.5	59.9	—12.3
85	Steam through cylinders	45,257.0	68,356.0	+33.8
83	Steam through cylinders per m. t. car mile	1,270	2,184	+41.8
86	B. t. u. through cylinders per m. t. ml.	1,410,213.0	2,188,011.0	+35.5
103	Indicated h. p. average for run	1,609.9	1,182.8	+36.1
110	Draw bar h. p. average for run	1,410.2	1,004.5	+40.4
114	Steam per i. h. p. per hour—actual	20.0	28.2	+29.1
115	Steam per i. h. p. per hour—equiv.	25.9	35.5	+27.0
117	Mechanical efficiency	87.58	84.98	+ 3.0
119	Thermal efficiency, i. h. p. basis	5.31	4.29	+23.8
120	Thermal efficiency, d. b. h. p. basis	4.65	3.65	+27.4
43	Fuel burned per hour	5,635	5,097	+10.5
44	Fuel burned per sq. ft. grate area per hour	125.2	113.2	+10.6
121	Fuel burned per hour—high speed condition	5,243	4,699	+11.6
122	Fuel burned per hour—low speed condition	5,941	5,347	+11.1
123	Fuel burned per sq. ft. of grate area per hour—low speed	132	119	+10.9
124	Fuel burned per sq. ft. of grate area per hour—high speed	116.5	104.4	+11.6

**All differences preceded by plus (+) are favorable to the superheated locomotive.

Conclusions.—It was observed, from the discussion on this subject, that there was an indication of a 5 per cent. saving in coal per M ton miles in the performance of the superheated locomotive with a brick arch, as compared with the same superheated locomotive without the brick arch. While the influence of the arch does not affect the coal consumption to any marked extent, yet we must recognize that there are other features favorable to the arch installation, such as the protection of the flues from sudden changes of temperature and also from stopping up, which advantages are well worthy of consideration. While a small difference in fuel consumption of 5 per cent. seems an insignificant quantity, yet when that difference is applied to a large coal consumption, the figures become quite appreciable.

From the review of Table XI showing the significant differences, attention was called to the fact that the superheated locomotive handled 16.1 per cent. more tonnage at an increase of 36.1 per cent. higher speed and at the same time showing an economy of 26.8 per cent. in coal per M ton miles.

(A vote of thanks was extended to Mr. Coddington and the paper was received without discussion.)

CONCLUDING EXERCISES

The following officers were elected for the ensuing year: President, F. F. Gaines (Cent. of Ga.); first vice president, E. W. Pratt (C. & N. W.); second vice president, Wm. Schlafge (Erie); third vice president, F. H. Clark (B. & O.), and treasurer, Angus Sinclair. The following executive members were elected to serve for two years: C. F. Giles (L. & N.); M. K. Barnum (B. & O.), and John Purcell (A. T. & S. F.).

Robert Quayle, in presenting ex-President MacBain with the ex-president's badge, said: It is a big job to be president of the American Railway Master Mechanics' Association, and it requires a big man to fill it. We have such a man in the president who is about to retire at the close of this meeting. He has served us well and faithfully. He has devoted his time and his energy to the welfare of this Association, and we are proud of the work that he has done. In token of this, Mr. President, I have been delegated to say these few words to you, and to hand you this badge. We trust that when you wear it you will take a justifiable pride in knowing that the Association thus honored you. We who are members, when we meet you on the rostrum or on the street, or anywhere during convention time, will give you honor, because you have been president of so great an association.

THE NEW VICE-PRESIDENT

At the election of officers for the ensuing year at the closing session of the Master Mechanics' Association, the three vice-presidents who have held office during the past year were moved forward, and F. H. Clark was elected third vice-president. It has been our custom to publish a photograph, with a sketch of the career, of the incoming vice-president, but as Mr. Clark left Atlantic City before the closing session, we were unable to obtain one.

Frank H. Clark is general superintendent of motive power of the Baltimore & Ohio system. He graduated from the University of Illinois in mechanical engineering about 1893, and is a good example of the successful college man in railroad work. His earliest business experience was in association with D. L. Barnes, the noted consulting engineer, and he also did some editorial work on mechanical papers before entering the service of the Chicago, Burlington & Quincy as chief draftsman. From this position he advanced by virtue of his ability and industry through the various positions of mechanical engineer, assistant superintendent of motive power and superintendent of motive power of the lines east of the Missouri river, to that of general superintendent of motive power of the Burlington system, which position he held for about six years. During this period he was associated with Daniel Willard, who was then operating vice-president of the Burlington system, and his ability was substantially recognized, after Mr. Willard went to the Baltimore & Ohio as president, by his being called to the latter system to serve as general superintendent of motive power of all the Baltimore & Ohio lines. He is noted as being conservative and careful in his judgment, very fair and thorough in investigating and deciding upon policies and devices, and, as a result of this, the remark was frequently made by inventors and owners of railway devices, during the time that he was at the head of the Burlington mechanical department, that they would rather have their material adopted for use by the Burlington system than by almost any other road, as it was generally recognized that things must have real merit to be accepted by the Burlington management.

Mr. Clark has done much valuable work for both the Master Car Builders' and Master Mechanics' Associations on many of the most important committees, and was the first general superintendent of motive power to be elected as president of the Master Car Builders' Association. He has always been a hard worker, while at the same time being an ardent advocate of healthful recreation. One of his most conspicuous traits is that wherever he has been employed in a business way he has always inspired the loyalty and best efforts of the men under him, while at the same time holding the fullest confidence of his superior officers.

ADDITIONAL MASTER MECHANICS' REGISTRATION

Jones, C. H., M. M., H. & B. F. M., Bothwell.
Kelly, O. J., M. M., B. & O., Haddon Hall.
Stewart, T. R., M. M., B. & O., Marlborough-Blenheim.

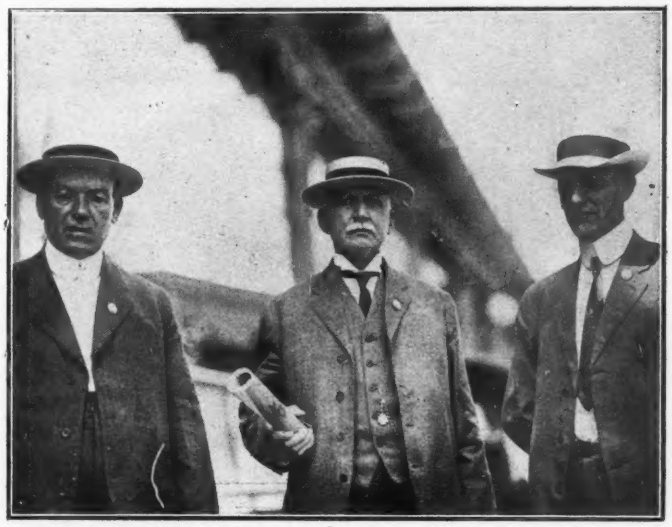
ADDITIONAL REGISTRATION OF SPECIAL GUESTS

Averell, W. H., Gen. Supt., Staten Island Rapid Transit.
Baird, W. A., Cashier, W. J. & S.
Branson, C. R., M. P. Inspector, Penna. Lines West, Brighton.
Darlington, Jesse, Jr., Foreman, W. J. & S.
Duncan, J. H., Foreman, P. & R., 115 Pacific Avenue.
Fahringer, M. W., Asst. Foreman, Philadelphia & Reading, Miller.
Fisher, Chas. A., Chief Train Dispatcher, Reading.
Gallagher, John E., Engineer, P. & R.
Gorrell, M. B., Machinist, B. & O.
Mitchell, C. E., Inspector of Mat'l, B. & O., Craig Hall.
Moore, Jno. H., Asst. Foreman, Atlantic City.
Plummer, A. M., Supt. P. Plant, W. J. & S.
Seiders, Irwin A., Road Foreman of Engines, P. & R.
Sensenbach, Chas., Foreman, Penna.
Stephenson, R. W., N. & P. Belt Line
Stephenson, L. S., N. & P. Belt Line R. R.
Sterner, W. P., Asst. Foreman, P. & R., Ramsey.
Van Schaick, Charles E., Combustion Expert, N. Y. C. & H. R.

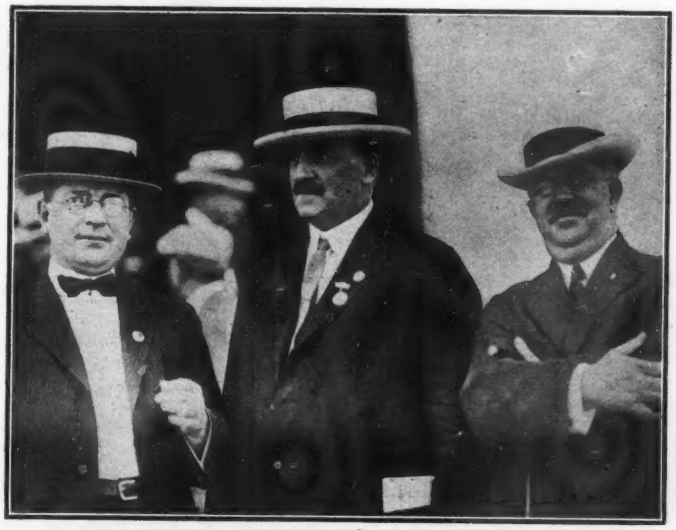
Conventionalities

Walter E. Coffin and Mrs. Coffin will return to Cleveland by the way of Maine. Their plan is to sample the fishing in some of the lakes of that State. Mrs. Coffin is the fisherman of the family.

Bruce V. Crandall, secretary of the Railway Supply Manufacturers' Association for the 1907 conventions, has been an interested visitor at the conventions this year. He is registered at the Chalfonte.



Left to Right—John Henry, Master Car Builder, Grand Trunk; Thomas A. Treleaven, Master Car Builder, Grand Trunk; K. F. Nystrom, Car Department, Grand Trunk



Left to Right: E. E. Hamilton, Supervisor of Oper. Stat., B. & O.; F. H. Clark, G. S. M. P., B. & O., and E. D. Gregory

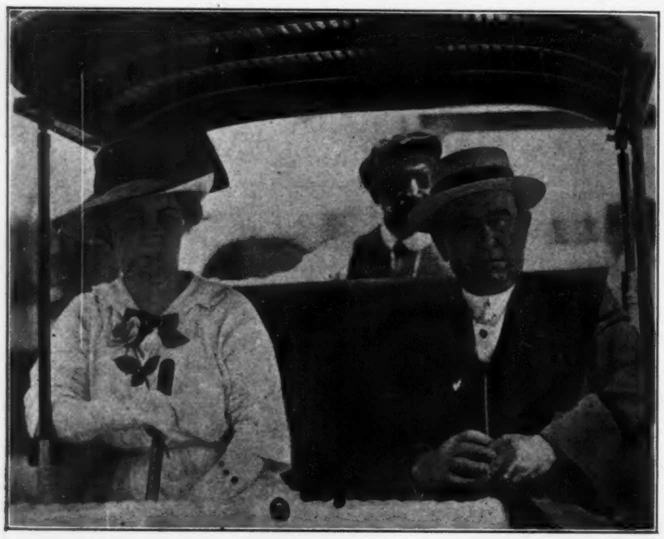
William H. Sauvage, of the Sauvage-Ward Brake Company, New York, was unable to get to the conventions this year until next to the last day because of a very bad cold settling in his ears. He is gradually recovering.

W. E. Dunham, supervisor of motive power and machinery of the Chicago & North Western, called yesterday to deny that he appears in the photograph published on page 1475

of the *Daily* for June 17. Those in the picture are George Durham, master mechanic, Delaware, Lackawanna & Western; Mrs. Durham and their three-year-old son.

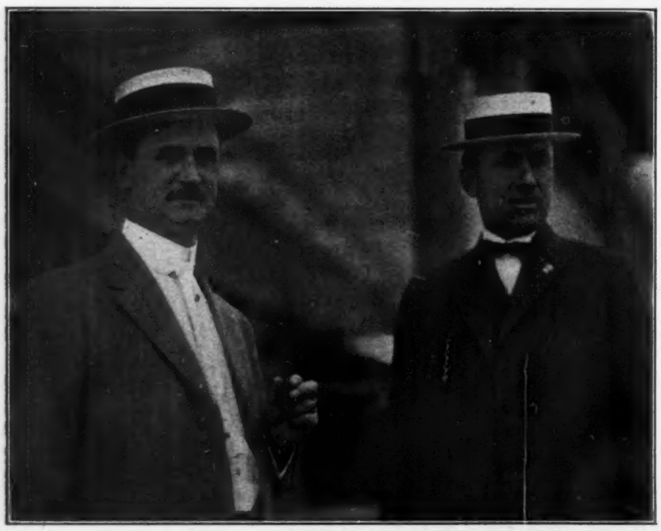
J. F. Graham, superintendent of motive power of the Oregon-Washington Railroad & Navigation Company, is a busy man; and is recovering from a recent severe illness. For these reasons he could not be at the meetings in Atlantic City.

Wm. Ewald, superintendent of motive power of the Cumberland & Pennsylvania, was forced to leave the conventions last Thursday owing to the death of Mrs. Ewald's father. He was able to return before the sessions were ended.



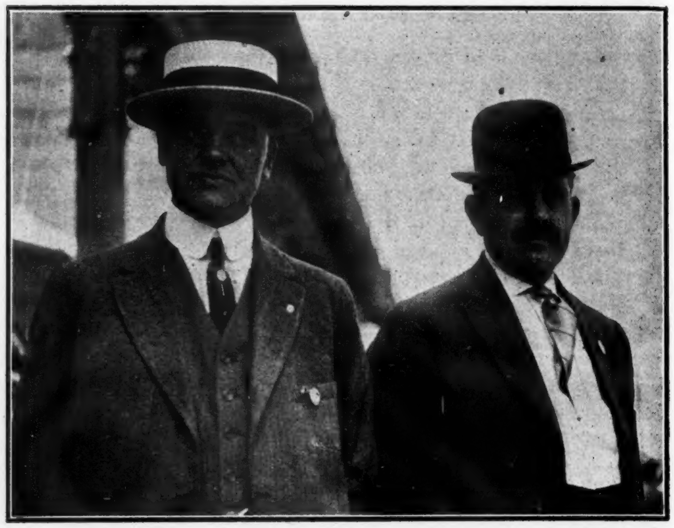
Charley Hogan, of the New York Central, and His Daughter Gertrude

The railway associations this year will miss the presence of E. A. Gilbert, general inspector of the motive power department of the Southern Pacific. Mr. Gilbert has traveled much of late and could not leave San Francisco to attend the association meetings.

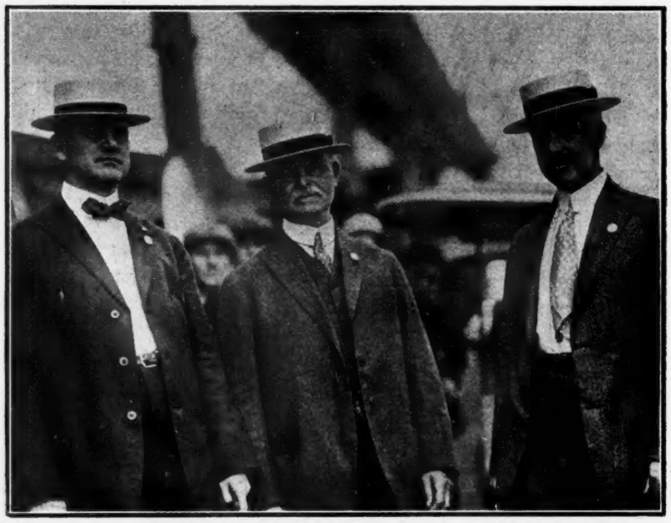


T. F. Barton (Left) and Geo. Durham (Right), Both of the Lackawanna

Wm. Forsyth, a regular attendant at the convention for many years, but who last year was in the far West at the time of the meeting, is with us again. He is now living in Philadelphia, where he located and settled down last October. With Mrs. Forsyth he had a most delightful visit to California, spending many months there.



Right to Left—Eli Minick, General Foreman Car Repairs, Lehigh Valley, and R. D. Wilson, General Car Inspector, Philadelphia & Reading

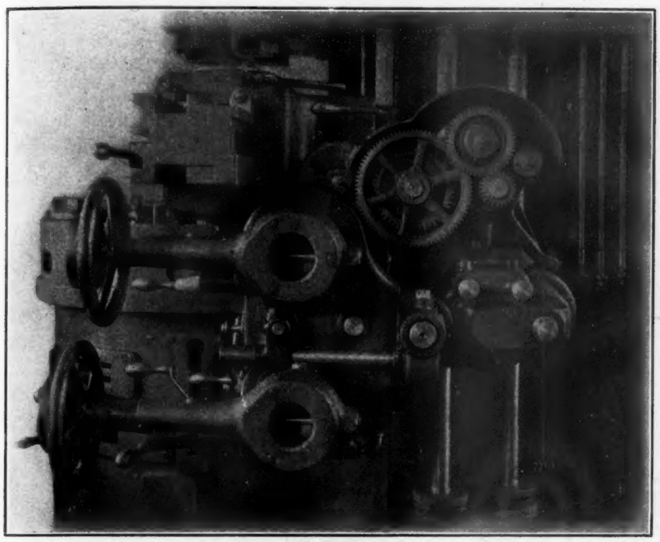


Left to Right: F. M. Graff, Special Agent Mach. Department, Erie; John McMullen, M. S., Erie, and P. J. O'Dea, Gen. Inspector, Erie

Left to Right: R. L. Williams, Midvale Steel Co.; E. C. Sasser, M. M., Southern Railway; B. McBride, M. M., Southern Railway; W. M. Herring, Chief Clerk, G. S. M. P. & E., Southern Railway

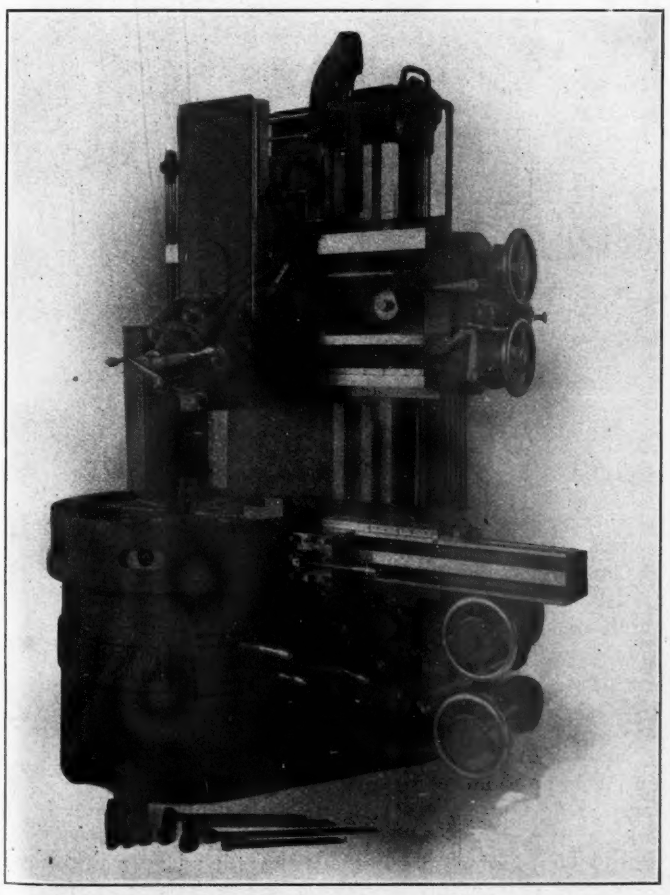
SIDE HEAD BORING MILL

A side head boring mill is on exhibition at the booth of the Niles-Bement-Pond Company which has a number of features of special interest. The side head can be operated on work up to 38 in. in diameter and the vertical head on



Thread Cutting Attachment in Position on Side Head

work up to 44 in. The side head is entirely independent of the cross rails and may be lowered below the table, permitting the increased swing. It extends entirely across and is



Boring Mill with Side Head Set Below Top of Table

mounted directly upon the column. This arrangement leaves but two movable joints between the cutting tool and the column, one for vertical and the other for horizontal travel; and all strains are taken on the full width of the column. The side head guide is long and narrow, having bearings of the square lock type with taper gib adjustment for taking up the wear. Sixteen independent feed variations and rapid traverse in all directions are at the operator's command, and a complete equipment of micrometer dials and observation scales is conveniently located for ease and precision in the control of the side head movement.

A thread cutting attachment in a complete unit is provided, which can be quickly applied to either the vertical or side head. In one of the illustrations it is shown in position on the side head. A forming attachment may be furnished for use in connection with the side head, which is suitable for taper turning and forming work such as crowning pulleys. As regularly furnished it is suitable for taper turning up to 15 deg. either side of the horizontal and vertical.

VANADIUM STEEL IN LOCOMOTIVE CONSTRUCTION

In view of the present increasing tendency toward the use of higher grade materials in the construction of the modern heavy locomotive, the accompanying charts are of interest, showing graphically the development during the last six years of the application to locomotives of vanadium steel and iron.

Fig. 1 shows the number of locomotives built each year for the railroads of the United States and Canada, from 1908 to the present time, on which this material has been used. Fig. 2 shows the percentage which this number in any given year bears to the total number of locomotives built that year. In 1908 when vanadium steel first received serious consideration as a locomotive material it was specified on only 50 locomotives, or only 2 per cent. of the total output for the countries considered. Last year over 1,100 locomotives, or 25 per cent. of the total, had vanadium parts. Up to May 15 of this year, vanadium steel has

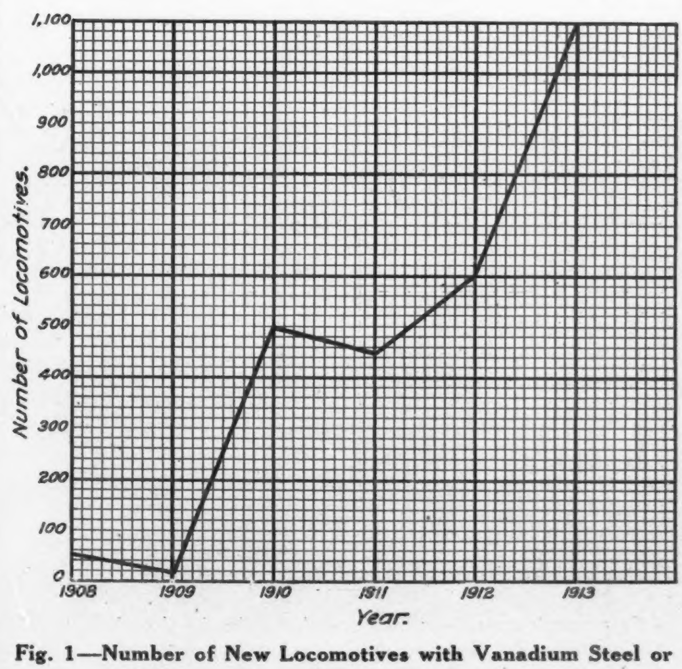


Fig. 1—Number of New Locomotives with Vanadium Steel or Iron Parts

been specified on 349, or 57 per cent. of all the locomotives ordered by the railroads of the United States and Canada.

These charts are plotted from official returns from the locomotive builders and the railroads, and from statistics as to the annual locomotive output published in railroad journals. The statistics on which the percentage curve is based, include engines of all classes, from Mallets to contractors' locomotives. Considering only heavier power, for which vanadium steel is chiefly advocated or considered, the percentages would be higher

than those shown in Fig. 2. Statistics show that last year this material was specified on 48 per cent. of all the locomotives weighing over 225,000 lb. built for the railroads of the United States and Canada.

The curve showing locomotives having vanadium parts includes only new power, and does not cover the number of loco-

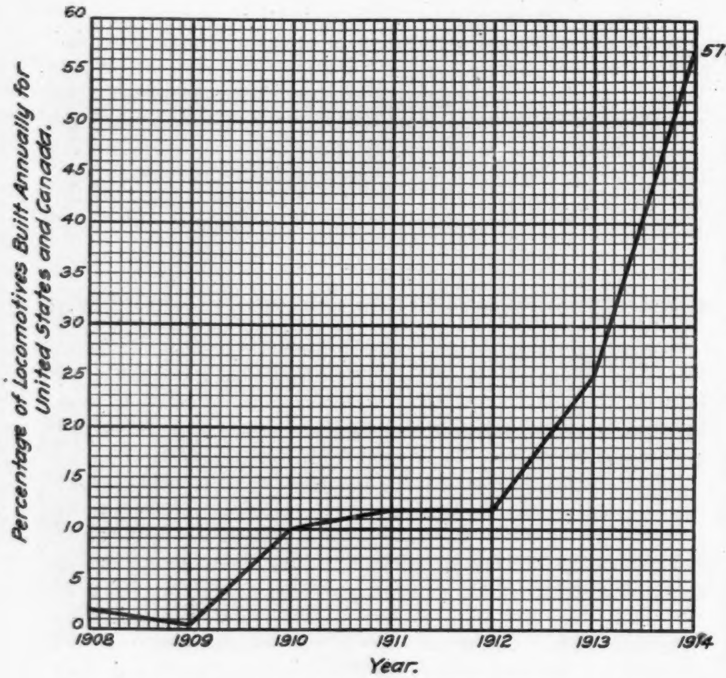


Fig. 2—Percentage of Locomotives with Vanadium Steel or Iron Parts to Total Production

motives to which vanadium steel parts have been applied in repair work.

The following table itemizes the different parts of vanadium steel and iron applied to locomotives built last year and ordered so far this year, and the number of locomotives so equipped.

Vanadium Parts Applied to Locomotives From January, 1913, to May 15, 1914.

Name of Part	Number of Engines Equipped	Number of Parts Applied
Driving axles	476	1297
Main rods	377	822
Side rods	284	1986
Frames	993	2054
Crank pins	198	612
Piston rods	69	138
Springs (engine and tender)	366	—
Engine truck axles	62	62
Wheels	—	700
Tires	—	1150
Cylinders (vanadium cast iron)	260	540

With the exception of wheels and tires this table applies to new power only.

Boltless Truck Side Frame.—A newly developed cast steel truck side frame is being exhibited by the Scullin-Gallagher Iron & Steel Company. It is designed to eliminate bolts, nuts and rivets from all fastenings. The journal boxes are secured in the jaws of the side frame by means of pins locked in position by flat keys. The brake hangers are secured in a similar way.

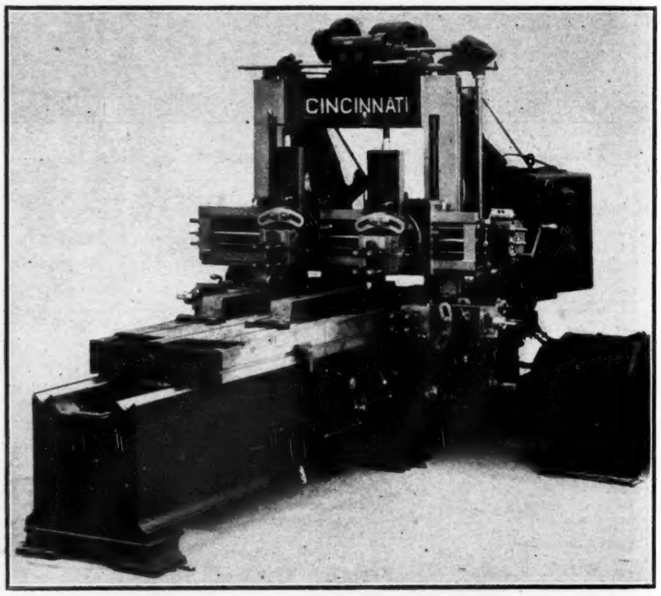
Staybolt Taps.—The Wiley & Russell Manufacturing Company is demonstrating the Lightning staybolt taps manufactured by that company by means of a section of a boiler. The two sheets are located as they would be when in position in a completed boiler. The staybolt holes have been punched and an air motor is used for driving the tap.

REVERSIBLE MOTOR DRIVEN PLANER

The illustration shows a 36 in. x 36 in. x 8 ft. heavy pattern planer, with four heads and a reversible motor drive, which is in operation at the booth of the Cincinnati Planer Company.

It was equipped with all-steel gears and steel rack, and is capable of very heavy cutting at high speeds. Ten cutting-speeds, from 25 to 60 ft. per minute and ten return speeds up to 100 ft. per minute are provided. One of the features of this machine is the rapid power traverse of the heads. This is simple in its operation, and available for service at all times.

The motor shown at the top of the arch delivers its power through spur gears to the rail elevating device, thence to the horizontal rapid traverse shaft at the top, which has a bevel gear meshing into the vertical rapid traverse shaft at the side of the housing. This, in turn, transmits its power to a pair of spur gears at the end of the rail. The regular feed is transmitted to the heads in the usual way from the friction on the end of the pinion shaft to the feed gears at the end of the rail by a segment and rack. The feed and rapid power reverse gears on the rail screws and rod are free to revolve until clutched



Reversible Motor Driven Planer

by a spool between them, which has a neutral position in which neither one is engaged. This prevents engaging both the rapid power traverse and the feed at the same time. Provision is also made to protect the mechanism against all accidents. The three handles at the end of the rail control the clutch spools while the handle just under these engages the rapid power traverse.

The rail and side heads are taper gibbed throughout and the rail heads are equipped with micrometer scales. The housings are extended to bottom of bed, securely bolted and doweled, and locked to the bed by two large keys. All gears are securely covered and guarded against accidents to the operator.

Heat Insulating Brick.—A heat insulating material made up in the form of brick which can be used on the outside of boiler settings or commercial furnaces, is on exhibition at the booth of the Armstrong Cork and Insulating Company. The bricks are composed of a special form of earth mixed with a small amount of clay and finely ground cork. In the process of manufacture the cork is burned out, leaving the brick with a porous structure of low heat conductivity. This material is claimed to transmit but one-tenth of the heat transmitted by firebrick or common brick.